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THE TRAINING OF MATHEMATICS TEACHERS.[1]

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The preparation of mathematics teachers of various grades is to be the main topic of discussion at the next conference of the International Commission on the Teaching of Mathematics, which is to be held at Munich, Germany, August 2-5, 1915. This fact forcibly directs our attention to the great importance of this subject and it should increase our interest in it at the present time. It is inspiring to know that we are considering a matter which is so prominently before the mathematics teachers of the leading countries of the entire world. As further evidence of the great present interest in the subject under consideration we may refer to the prizes recently offered in Germany for the best essay on the further development (Weiterbildung) of the German teachers. The monetary values of these prizes are five hundred marks, three hundred marks, and one hundred marks respectively, and the competing essays are due on or before October 15 of next year. Among other things these essays are to discuss the best ways of using the facilities already at hand, and of providing additional facilities for the advancement of the interests of those already engaged in teaching.[2] Keenly impressed with the timeliness and importance of our subject we turn to consider some of its features.

In considering the request to prepare a paper for this occasion on "The Training of Mathematics Teachers" the word *training* first attracted my attention. It occurred to me that we train dogs, horses and monkeys, but we educate lawyers, doctors, and preachers. We train soldiers, clerks and nurses, but we educate generals, statesmen and sanitary engineers. We often speak of a normal school training and of a university education.

[1]Read before the Mathematics Section of the Central Association of Science and Mathematics Teachers, Chicago, November 27, 1914.

[2]Cf. Zeitschrift für naturwissenschaftlichen Unterricht aller Schulgattungen, October 2, 1914, p. 521.

These thoughts naturally led to the question whether the preparation of a teacher should be called a training or an education. Is the teacher's activity comparable with motion in grooves, or with motion guided at every moment by an alert mind which utilizes promptly every advantage arising from the changing conditions? Is there a lesson in the fact that the terms training-school and training-college are associated so prominently with a normal school in some of our large American dictionaries, such as the Century, Webster's International, and the Standard?

Although the word training is sometimes used in a sense which is incompatible with the mental leadership which teachers should exert, at least in their class rooms, yet this word is often used with a broad and noble significance. As it is associated with the terms mathematics and teachers, in the heading of our paper, it is reasonable to suppose that the word in this connection should receive its most favorable significance. Hence we shall assume, in what follows, that the training of mathematics teachers does not only include their scholarship, but that scholarship is the main element in this training. In other words, we shall assume that our subject means really the *education* of mathematics teachers.

As I understand it, the most serious mathematical problem in America today is the proper training of the mathematics teachers—especially of those engaged in the teaching of secondary mathematics. Fortunately, many of the American Universities have, in recent years, drawn liberally on their large resources in their efforts to help teachers in the secondary schools. The recent transformations of our universities in favor of the teachers are perhaps unprecedented, in suddenness and extent, in the history of higher education in America. As evidences of these transformations we may mention the rapid development of the summer sessions and the schools of education. In both of these directions the renowned university of this city is among the leaders, and this leadership should be an inspiration in the further development of this Association, which should soon grow to twice its present size.

If it is true that in the teaching of first year mathematics, "in general, more poor instruction is found than in any other place in our educational system,"[3] our university schools of education have a fine opportunity for home mission work.

[3]American Report of the International Commission on the Teaching of Mathematics. Committee V, 1912, p. 12.

On the other hand, the presence of the schools of education in university atmospheres may lead to saner views as regards the relative importance of learning the subject and learning how to teach it. Indirectly it ought to lead to greater sympathy between the university and the normal school by facilitating the acquaintance of their teachers.

One of the most important questions as regards the training of mathematics teachers is the division of his time between courses devoted to mathematics and those relating to methods of teaching. All are agreed that the number of the former courses should be an increasing function of the advancement in the subject matter taught. That is, an elementary teacher of mathematics should not be expected to take as many such courses as a teacher of secondary mathematics, while the teacher of higher mathematics may reasonably be expected to take more courses of this kind than the teacher of secondary mathematics.

With regard to courses relating to methods of teaching there seems to be less general agreement. Judging from the way things have actually transpired it would appear that the number of courses in methods of teaching might be a decreasing function of the advancement of the subjects taught. That is, the teachers of elementary mathematics seem to have taken the most courses properly belonging to a school of education, the teachers of secondary mathematics have taken fewer of these courses, and the teachers of higher mathematics have generally taken none of them unless they began their teaching in secondary schools.

Without trying to justify present relative conditions there are evident reasons for a decrease in the number of courses relating to methods and their history with the advance in the number of courses relative to the subjects to be taught and their extensions. If a student takes a large number of courses properly belonging to the mathematical department he has more opportunity to profit by the successes or failures of his teachers. Moreover, he will normally attain a greater maturity of thought, and hence his training in methods of teaching does not need to be so detailed. This does not, however, necessarily justify the fact that so many of the instructors of the first year courses in mathematics in our universities have not taken any courses similar to those offered in the schools of education.

There is sometimes a kind of tyranny which drives university students who expect to teach secondary mathematics into the

classes of the school of education in view of the fact that many universities maintain appointment bureaus which are in close touch with their schools of education. In so far as the courses pursued by these classes actually contribute towards the improvement of teaching this special influence may be desirable, but it clearly tends to modify the influence which the university atmosphere should exert on the schools of education. In view of the great need, on the part of teachers, of a more comprehensive knowledge as regards the subjects they expect to teach, it is very desirable that courses on methods should not be unreasonably extended.

If one would ask me how much scientific training teachers of mathematics in our secondary schools, colleges, and universities ought to have, my reply should be, the largest possible amount. There is no upper limit to the amount of desirable mathematical knowledge for all those who teach this subject. The minimum that can be permitted must be determined by the law of supply and demand. The experience of some of the older countries, such as France and Germany, indicates that our present minima standards are far below those which we have a right to expect in the future, and that it is reasonable to expect rapid improvement to continue for a long time.

The reports of the different American committees of the International Commission on Teaching of Mathematics contain various lists of studies which those expecting to teach secondary mathematics are advised to pursue. On page 13 of the report of Committee No. V, it is stated that "on the side of pure mathematics we may expect the calculus, differential equations, solid analytic geometry, projective geometry, theory of equations, theory of functions, theory of curves and surfaces, theory of numbers, and some group theory. On the applied side we should demand a strong course in mechanics, theoretical and practical astronomy, descriptive geometry, and some mathematical physics with a thorough course in experimental physics." It may be observed that this list includes eight subjects in pure mathematics beyond the first course in calculus.

Although this list of suggested subjects may seem excessive in view of present conditions, it is said to be no more severe than the requirements in France today for the secondary teaching license known as the "agregation." Moreover, the given list includes only the basic courses which are recommended. It is followed by courses on the history and teaching of mathematics,

on a critical study, of an encyclopedic nature, of elementary mathematics from a higher standpoint, on applications of mathematics to surveying and other subjects, and on teaching of secondary mathematics, with practice teaching under expert supervision. Such high attainments on the part of the teachers would tend to dignify the profession of teaching and would add enormously to the enjoyment of the teachers. For what can give us keener enjoyment than the observation of the gigantic interplay of mathematical concepts reaching down to the very elements and towering into realms of the unknown.

With respect to courses in applied mathematics it is perhaps of interest to observe that the rules for the examination of Prussian mathematics teachers in the secondary schools, as revised in 1898, introduced applied mathematics as one of the possible subjects to be offered for examination. Hence the candidates for positions as mathematics teachers can now take mathematics as a major subject and applied mathematics as a minor.[4] The subjects specified in applied mathematics are descriptive geometry, technical mechanics, especially graphic statics, geodesy and theory of errors. It is not intended that these subjects should take the place of courses in pure mathematics, but they should generally be accompanied by the latter courses. In fact those who elect applied mathematics are compelled to elect also pure mathematics, at least in Alsace-Lorraine.[5]

It should also be emphasized that it is very desirable that the student should write up courses in higher mathematics from his lecture notes, and thus construct treatises of his own on various mathematical subjects. This practice will lead to a much deeper penetration into the various subjects and will give experience in the arrangement and in the grading of the various mathematical steps. It has most of the advantages which the authors of textbooks enjoy, and it avoids most of the drudgery of the work connected with textbook writing. A teacher who could not write a textbook on a subject is not prepared to teach the subject. Moreover, writing up the notes on an advanced course leads to methods of consulting the literature and to independence of thought.

I desire to emphasize the fact that the satisfactory following of mathematical courses does not constitute a mathematical education. It merely exposes the student to such an education. A

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[4]Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht, Vol. 30 (1899), p. 230.

[5]Abhandlungen über den mathematischen Unterricht in Deutschland. Band LL, Heft 7 (1911), p. 58.

deep craving to know still more and an intense interest in the infinite variety of the different points of view must persist in the teacher as long as he can expect to be a worthy member of the teaching staff of any institution. In fact, this interest and craving, coupled with a fair knowledge, constitute even more important elements in his success than the possession of an extensive knowledge relating to the subject in hand. This extensive knowledge is desirable mainly because it tends to awaken and foster this deep interest and craving.

In view of the intimate relations between various mathematical subjects it is natural to reach the conclusion that a mathematician can get along with comparatively few fundamental facts because he should be able to deduce from these an infinitude of others. Hence the active mind becomes the mathematician's reference library. That is, the mathematician looks inward rather than outward for his knowledge. While there is much truth in this point of view, it is also true that with the growth of the developed parts of mathematics there comes a growing need to know what others have done. The mathematics teacher should therefore be trained to find things in the literature as well as to deduce required results from fundamental principles.

While the English language is poor as regards general mathematical literature, it contains some of the very best works of reference in the world. The efforts of the Royal Society of London towards securing reference works of great usefulness deserve the highest praise, and all teachers of mathematics should be familiar with the mathematical volumes of the *International Catalogue of Scientific Literature,* and with Volume I of the *Subject Index of the Catalogue of Scientific Papers.* This index, published six years ago, is the most useful single volume for mathematical references, covering the periodical mathematical literature for the entire nineteenth century.

Progress can be assured only by utilizing as fully as possible the work of our predecessors and by avoiding unnecessary duplication. Even in the preparation of such a paper as this it seems very desirable to consult other writings along this line, such as may be readily found by means of the given indexes, and, for the period from 1900 to 1912, in the useful *Bibliography of the Teaching of Mathematics* by Smith and Goldziher. Among the valuable literature on the subject under consideration I desire to direct especial attention to two reports entitled, "On

the Preparation of College and University Instructors in Mathematics" and "Training of Teachers of Elementary and Secondary Mathematics," which appeared in the *American Report of the International Commission on the Teaching of Mathematics,* Nos. XII and V, respectively.

According to the report of the Committee III of the *American Report of the International Commission of the Teaching of Mathematics,* 1911, page 78, "the fight for the recognition of the principle that high school teachers should have the training represented by the bachelor's degree is practically won. There is but a small portion of the country where this is not at least a clearly recognized ideal, however remote from realization in practice. . . . . A notable example of a state in which the minimum requirement for high school teachers is unusually high is California. There the minimum requirement is essentially that the candidate must present evidence that in addition to eight years in high school and college he has done a half year of graduate study in a university belonging to the 'Association of American Universities,' and a half year of practice teaching in a high school conducted for this purpose by such a university."

In insisting on high minima mathematical requirements we should not lose sight of the fact that there are some disadvantages in scholarly requirements which are so high that the number who fulfill them is scarcely equal to the number of vacancies. For instance, the universities which insist on the Ph. D. degree for appointment to instructorships have sometimes been compelled to appoint men who would not have been first choice if the minima scholarly attainments had been lower. On the whole, high scientific requirements tend towards improvement along the most important lines, and teachers should be leaders in advocating such requirements. Notwithstanding occasional disadvantages high minima requirements are probably the surest means of securing real progress.

There is perhaps special reason for raising the question of minima requirements at the present time. The great European conflict which is now in progress is apt to direct unusual attention to our educational system. There are no good reasons why we should not become leaders in education, and leadership implies high attainments. The rapid advance in our educational facilities, especially the rapid improvements in our libraries, are elements of great significance. The freedom from compulsory military service in our country, combined with our great natural

resources, should tend to give us an advantage which should be quickly seized and utilized to the utmost. The abbreviation U. S. A. should represent the *Uppermost in Science and in Arts.*

In a recent communication of the United States Commissioner of Education it is stated that "This is America's opportunity. Thousands of students who have been attending universities in Europe will be obliged to look elsewhere for higher education, not only this year, but perhaps for years to come. Many foreign students are already coming to us, many more will come as the result, direct and indirect, of present events. We have now a supreme opportunity to demonstrate our capacity for intellectual leadership.[6] This intellectual leadership can scarcely be attained unless our teachers first become leaders among the teachers of the world, and this implies higher intellectual attainments.

Among the non-mathematical courses which are fundamental in the training of teachers are those which lead to a good reading knowledge of French and German. The poverty of the general mathematical literature in English is very lamentable, but even if this literature were more extensive it would still be desirable to keep in direct touch with the works of such prominent leaders in the mathematical sciences as the French and Germans have always been. In fact, the Italians are not far behind these two nations in regard to mathematical developments of fundamental importance, and a good reading knowledge of Italian is also a very helpful accomplishment for those who desire to keep in touch with the best new developments along their lines of special interest.

As an instance of the need of a reading knowledge of foreign languages we may cite the fact that it does not appear likely that there will ever be an English translation of the large mathematical encyclopedias which are now appearing in the German and French languages. On the other hand, certain parts of these encyclopedias deal directly with the work of teachers of secondary mathematics. For instance, the part of the German edition, which appeared in June of the present year, and which treats the subjects of elementary geometry from the standpoint of modern analysis, and the synthetic treatment of elementary Euclidean and non-Euclidean geometry should be read by every teacher of elementary geometry. As there is no good mathematical encyclopedia in the English language it is so much the

[6] *Science*, September 18, 1914, p. 406.

more important to be able to use these excellent works in foreign languages.

As another instance of the usefulness of a reading knowledge of foreign languages it may be cited that the greater part of the extensive literature which has appeared recently under the general direction of the "International Commission on the Teaching of Mathematics" is in foreign languages. Moreover, many of the best mathematical periodicals are published in French or German, and the live teacher welcomes the regular visitors in the form of journals, bringing prompt information in regard to the best that is being done in the various progressive countries of the world.

We are living in an age of mathematical team work, and the mathematical journals constitute the blood-vessels of the world-wide mathematical body. By conveying promptly new and important advances from one part of the world to another these journals direct attention to new fruitful fields, and thus tend to avoid, to a considerable extent, wasteful duplication. Teachers who have once experienced the many advantages of such journals can not feel comfortable without them unless they have lost the lively interest in their subject which is essential for real success.

An important secondary use of such foreign journals is to maintain a good reading knowledge of one or more of the foreign languages. As an instance of one journal, adapted to the needs of secondary teachers, in each of the three foreign languages which are most important from the standpoint of mathematicians, we mention the following: *L'Enseignement Mathématique, Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht aller Schulgattungen,* and *Periodico di Matematica.* Those who would like to read a Spanish Journal would probably find the *Revista de la Sociedad Matemática Española* very satisfactory. It may also be mentioned that by supporting mathematical journals one contributes towards their improvement and hence towards the advancement of our subject.

It may be argued that the high minimum requirements which have been suggested, and the deep interest in mathematics which has been lauded might tend to absorb the energies of the secondary teachers to such an extent as to interfere with their greatest success in the class room. Students of the high school age appreciate the kind assistance of teachers more highly than their erudition. They appreciate the personal interest of teachers

more keenly than an assurance that these teachers are spending their best thoughts on mathematical developments which seem at an almost infinite distance from their present attainments.

It must be admitted that there are instances in the university and in the high school where high scientific attainments are coupled with selfishness and indifference towards students. It would be, however, difficult to prove that this selfishness and indifference are due to the high scientific attainments. In most cases it would probably be found that these attainments adorn an otherwise unbearable character, and constitute its main redeeming feature.

High scientific attainments tend to lessen very much the necessary special preparation of the teacher. While it is doubtless desirable that a teacher should prepare himself specially for every daily recitation, it is doubtful whether a teacher who could not work promptly before a class all the problems of the textbook, without such preparation, is really prepared to conduct a recitation by means of the textbook. There is good reason why he should know much more about the subject than the author of the textbook knew about it when he wrote the book for he is exposed to a greater variety of questions. At least he should know many things about the subject which are not mentioned in the textbook.

This wide knowledge should inspire confidence on the part of the student and this confidence should not be used to transfer book-idolatry to teacher-idolatry, but it should, on the other hand, lead to a study of the subject instead of a study of the textbook. A study of the subject is apt to reveal limitations on the part of the teacher which can easily be concealed by following the textbook, but these limitations should be frankly admitted. Very difficult matters lie at the threshold of some of our most elementary subjects.

If one thinks of mathematics one may have two very distinct views. To some mathematics seems to mean the mathematical developments which are found in the literature. That is, from this standpoint one might imagine a collection of all the mathematical literature that has been preserved, either directly or indirectly, and say "Behold! here is mathematics. With the exception of actual duplication this is the size of mathematics." A more correct view is to regard this literature as representing products in various stages of manufacture into which the metals taken from the inexhaustible mathematical mines enter in various

degrees. The mathematical historian arranges these products so as to exhibit the order of manufacture and the changes of views as regards objectives. He frequently delights in collections of antiques. The pedagogue studies the utility of the various manufactured products for particular ends, and practices the art of polishing them so as to present the most attractive appearance. The bibliographer lists these various products and determines for himself when the mathematical elements which enter into their composition are of sufficient relative importance to class them with the mathematical products. G. Valentine of Berlin, Germany, has made a list of 150,000 titles which is supposed to be a complete list of mathematical writings up to the beginning of the present century.[7] This is the most extensive list of mathematical writings that has yet been prepared and its compilation required the spare time of its author during a period of twenty-five years.

The mathematical investigator spends most of his time in the mathematical mines and uses the mathematical literature mostly as a guide to rich deposits. In fact, all students of mathematics should regard the literature as an aid and not as an end in their study. To a real mathematical student the literature often appears like the dead leaves which have fallen from the trees of an unlimited mathematical forest. "When knowledge is dead we bury it in books." The real life is in the subject and not in the books on the subject. All mathematics may be divided into two parts; viz., the developed part and the undeveloped part. The former is of finite extent and consists of the mathematical literature together with the fringes in parts, representing developments in the minds of living men. The latter part is supposed to be of infinite extent and is awaiting the investigator.

The training of the mathematics teacher is one of the serious questions calling for concerted action at meetings of this kind. Our slavish dependence on the textbook is largely a result of poorly prepared teachers. The students should feel that they are studying subjects under the wise guidance of a teacher rather than under the wise guidance of a textbook. The latter may serve to furnish illustrative examples, and to refresh the memory in regard to fundamental principles. The remark by Max Simon[8] to the effect that a logarithmic table is the only absolutely necessary mathematical handbook of the student should convey a useful lesson to many teachers.

[7] G. Eneström, *Bibliotheca Mathematica*, Vol. II (1910-11), p. 227.
[8] *Entwicklung der Elementar-Geometrie im XIX Jahrhundert*, 1906, p. 26.

The secondary teacher should always feel that there is an open highway for him towards a university professorship. It is not implied that all should have their eyes on this highway, but young men who are extremely interested in their further scientific development have a right to receive inspiration from such prospects. In Germany such eminent investigators as Carl Neumann, Lazarus Fuchs, Leo Königsberger, H. A. Schwarz, Georg Cantor, Eugen Netto, and Arthur Schoenflies have secured in recent times university professorships in mathematics after serving for shorter or longer periods as secondary teachers.[9] In America the transition from the high school to the university should be more easy than in the older and more conservative countries even if the improvements in our universities tend to make this transition less easy unless the standards of scholarship in the high school are raised correspondingly.

In closing I desire to stress the fact that the secondary teacher who enters upon his profession after graduating from a university should not consider the changes as comparable with coming from the flower garden of science to the dusty road of practical life. He should, however, realize the fact that success in his profession calls for a faithful devotion to the duties of his position, which generally leaves comparatively little time for the quiet strolls through the rose gardens of science which university days have endeared to him. The dignity of service and the joy of usefulness should endear to him his new position, but he can not afford to forget the rose garden of his university days, and his vacations and spare time should be freely used to return to the joys of the student who studies because he delights in it.

May we not hope that the secondary teachers will soon have sabbatical years, and will use them to renew their scientific vigor and to drink deeply at the fountains of knowledge where the scientific atmosphere should be clearest and purest, viz., at our great centers of learning. If the university professors, with more ample time and with better facilities, need the sabbatical year, the secondary teachers have still greater need of it. Such periods of restoration would doubtless do much to elevate the spirit in our secondary schools, and they would doubtless instill a more healthy tone into our entire educational system. A community and a nation can well afford to be liberal as regards those whose influence is most potent in inculcating high intellectual ideals in those who will so soon constitute the intellectual and the moral forces of the land.

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[9] Lorey, *Staatsprüfung und praktische Ausbildung der Mathematiker*, 1911, p. 105.

PIKE'S PEAK NOT SINKING.

Denver dispatches stating that recent Government surveys show that Pike's Peak has sunk 39 feet in the last three years are easily explained. Somebody has simply been comparing the exact altitude of the mountain, recently determined by the United States Geological Survey as 14,109 feet, with old railroad or barometer figures of elevation. As a matter of fact, to have come within 40 feet of the actual elevation shows a good job of surveying for the early days when Indians were plentiful and instruments poor, for, after all, there is no royal road of determining the altitude of any point. It has to be done today just as it had to be 100 or 1,000 years ago, by a series of sights from the ocean shore. To obtain the elevation of Pike's Peak means that surveyors have had to run levels all the way from the Atlantic Ocean, or the Pacific, to the top of the mountain. Thousands of sights had to be made. Of course, when the Geological Survey about five years ago established the exact elevation of Pike's Peak the engineers did not start at the sea level; they took the nearest point to the peak which had been previously determined by former level surveys. When the summit of the peak was reached a bronze tablet with the following inscription was cemented into the rock:

"U. S. Geological Survey, George Otis Smith, Director,
PIKE'S PEAK, Latitude 38° 50′ 26″, Longitude 105° 02′ 37″,
U. S. Standard, Elevation above sea 14,109 feet, 1908."

There is but slight likelihood of the altitude of this tablet changing within the life time of the present generation, or for that matter within the lifetime of the American Republic, however long we may expect it to endure, unless some relic hunter removes the tablet, and in such an event he will make himself liable to a fine of $250.

The Geological Survey has published an excellent engraved map known as the "Pike's Peak Special Map," which includes Colorado Springs and the adjacent country, covering an area of about 200 square miles. On this map is shown every physical detail of the country and the elevation not only of Pike's Peak, but of scores of neighboring mountains ranging from 10,000 to 13,000 feet in height. Streams, lakes, roads, trails, houses, etc., are also portrayed in their exact relative positions.

ALUMINUM FOIL.

The manufacture of aluminum foil has developed into a considerable industry in southwestern Germany. It is used in place of tin-foil as a wrapper for candies and fruits, and it is said to possess advantages over the tin. The sheets are rolled cold, annealed in a vacuum retort and then gradually cooled.

THE VOLUNTEERING SYSTEM.

By Mrs. Jane Pollock Anderson,
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In condemning the final examination as a means of determining the pupil's standing, I suggested a substitute, which I have been working upon for the past six years.

Though there were many flaws in it in the beginning and still a few after six years, yet on account of its justice, it is a very satisfactory method to teacher and pupil.

I am endeavoring to describe it somewhat fully, in the hope that I may help those just beginning to use it, to escape some of the disadvantages I have worked out of; and yet, each one who tries it, will have to work out his own problem to a certain extent.

I call it "The Volunteering System," because each pupil volunteers his answer upon every question asked and in such a way that he disturbs no other pupil.

This system was adopted as a method of doing away with several apparent injustices in the class room; and also of accomplishing certain results that seemed almost impossible by any other means. The injustices were: one pupil getting the credit for giving a recitation, that many others in the class could have given as well or better; one pupil getting the only question he could not answer, while the others were fortunate enough to get questions they could answer, though they might not have been able to answer other questions; some pupils being called upon oftener than others and thereby getting a more pronounced success or failure; some pupils being more disconcerted than others by being called upon to recite, and therefore giving a poorer recitation than others who were no more competent. The results to be accomplished were: better attention and more interest on the part of the whole class because each question was put to all; more quiet in that no one spoke out and no one urged the teacher to call upon him by the raising and even vigorous shaking of hands; more self-reliance and assurance on the part of the pupil, in that he had to take a stand for what he thought was right; more of a chance for the weak pupil, in that he had time and quiet to think out his answer, undisturbed by the usual monopoly of the so-called sharks, and the same chance as the shark to get up, showing that he wanted a chance to tell what he knew.

To give a little clearer idea of how these results were accomplished, I will go into detail as to how the system is managed.

Suppose we have upon the board the figure for the proposition: "If two triangles have two sides of the one equal respectively to two sides of the other and the included angles unequal etc." and the triangles with the smaller angle placed upon the other. I say to a class, "Volunteers, how many see in the figure on the board, the figure of a proposition we had last week?" This being a question whose answer depends entirely upon their power of observation and association of ideas, perhaps no one rises immediately, but everybody studies the board intently. Finally one or two get up, happy and exultant but in no way disturbing those still trying. Others get up and then others and soon I call on the weakest one up for his answer. I ask for those who agree with him and they signify agreement by raising the hand. I count them, take in who they are and tell them to sit down. I call on the weakest one left standing and go through the same process until none is left standing. I have given no sign of approval to any one of the answers. Then I say, "Those who said 'the sum of the diagonals of a quadrilateral is greater than the sum of two opposite sides' stand up again." I give these pupils one mark.

In using this system, the class soon joins the teacher in trying to conceal all signs of agreeing or disagreeing until they are asked to show their agreement by raising of hands. At first they had hard work to keep back their enthusiasm for the right answer and their disapproval of the wrong. But they soon saw that if the bright pupils revealed their ideas the weak ones would raise their hands for what the bright ones thought correct and that would never do. The pupils are just as anxious for justice as we are, and the results of this system depend upon very careful management as you can see. Careless observers might think that this method would lead to an enormous amount of guessing and taking of chances but this is not the case.

I found my pupils very conscientious; they could be trusted to such an extent that I finally changed my system of bookkeeping. At first my class book pages were diagrams of the seating of my classes, a square for each pupil, and without looking at the book, I could put a straight mark in a pupil's square for every mark he received. Gradually, I allowed them to keep track of their own marks, not interrupting the recitation to take them but waiting till the end of the hour. They certainly checked each other up! They knew just how many marks their neighbors ought to have. Then, finally, I let the marks go for a week or two; the

only objection to this was that sometimes they lost the books in which they kept track. This was not such a calamity, for in some of the advanced classes, the pupils themselves suggested doing away with the marks entirely, because by this system, not only the teacher, but the pupils can tell the rank of nearly every pupil in the class in relation to every other pupil. This shows how little need we had for a final examination. You understand that the number of marks they received did not decide percentage. It simply designated rank or order.

That takes me back to the question of why I vary the number of marks given according to the style of the question asked.

Suppose I say "Volunteers, give me one condition under which angles are equal," or "Give me one condition under which triangles are equal." On correct answers to this type of question I give two marks. That is, on all subjects which they ought to know thoroughly by review, as well as on all questions discussed thoroughly the day before, I mark double. There is room for discussion here. I fought it out in my own mind, and talked it over with every class. The pupils think it fair, but every day of my life I felt a little unjust when I marked more on the review than on originality. But this is my best excuse, we have a greater number of pupils always, who can learn a lesson by plodding, after it has been explained, than we have of the original kind. And while I do all in my power to give the original pupils a chance, the others must be given an incentive for getting it even second hand.

In algebra, a question of that kind would be "Volunteers, what are we doing?" or "What did you just do?" In my classes, that question has one of seven answers. I never accept the answers, "simplifying," "changing," "canceling," "transposing," and "changing signs." This question needs no originality, it calls for application merely and is marked double. Another question of that kind in algebra would be from a problem that ends with "If $\frac{1}{3}$ of the second be subtracted from 5 times the first, the remainder will be 16. Find the numbers." I ask, "Volunteers, what does 16 =?" or "What label do we give to 16?" After the pupil has been taught to label the known quantity in the problem, before he takes any other step, this question can be answered by a careful reading of the problem. So the answer "16 equals 5 times first less $\frac{1}{3}$ of second" gains two volunteer marks.

In questions of this kind, which the pupil could answer by simply being conscientious, where there is no excuse for a wrong

answer, I often distinguish between those up with the wrong answer and those who remain in their seats. The pupils feel this difference. For instance, when wrong answers are given, pupils in their seats raise their hands to say "Oh, I thought of that, but I knew it was wrong so I didn't get up." I tell them it is better to be in their seats working off an honest doubt, than to be up satisfied with a false conviction. There is a question here, too, as to whether all in their seats deserve more than those with wrong answers. Some may not be trying.

In stating a new proposition to a class, my first question is always the same. It is "Volunteers, what question are you asking yourselves?" Here again, only those who have been trained to do geometry by the inductive method would know what I mean. My pupils have no excuse for failure on this question and they feel that the habit of asking it, launches them into the heart of the proposition as nothing else would. For instance, if the proposition asks them to prove angles equal, their first question is, "When are angles equal?" If to prove lines parallel, "When are lines parallel?" If to prove a four-sided figure a parallelogram, "When is a four-sided figure a paralleogram?" You can easily see that we have many answers to these questions, and we keep them classified in notebooks and fresh in our minds by daily use of them.

The only reason for varying that first question is to keep my pupils from being dependent upon me, so sometimes I say "Volunteers, who can take the first step in this proposition?" That *first step* must be to ask themselves the question, the second step to answer it. Another thing I sometimes do to help impress upon them this first step is to state the proposition, wait a few seconds and then say "Volunteers, those who have already asked themselves a question, stand up," in this case I do not wait for them to get up slowly and perhaps ask the question on the way up. I call immediately on the weakest one up.

I cannot with justice get away from the step by step volunteering. Sometimes I try to mark on whole propositions but I am forced into the step by step method by a situation like this: some who volunteer to do a whole proposition may fail on one step in the middle of it, and I say "Count that one-half proposition." Then those in their seats may say "I could have gone that far, that was the step that kept me from getting up." So now when I give the class a chance to get proposition marks, I allow them to count one volunteer mark for each step until they fail on a step;

if they go half way through I call it half a proposition, if all the way through a whole proposition. The pupil who has the greatest number of whole propositions for a month is higher than the pupil who has the greatest number of volunteer marks. This is, of course, the only fair thing for the plodding pupil who hasn't much originality or who is slower to grasp ideas the first time they are presented. The bright pupil is sacrificed to a certain extent, as he always will be while we are compelled to keep in one class those of such varying ability.

Some famous man, Henry Ward Beecher I think, attributes his power of self-reliant reasoning, his power of reaching a conclusion, making a decision and then abiding by it, to an experience like this: A teacher sent him to the board to do a problem. He reached a certain step and she said "Wrong," he worked it over several times only to get the same result at that step and then gave up and went to his seat. The teacher sent two or three other boys to the board, one after the other. All had the same experience. Finally, one boy went to the board, and although he had the same result for this step, he paid no attention to her "Wrong," but worked right on to the end of the problem. When the teacher said, "Good work" and gave him credit for the problem, the other boys rebelled, saying, "Why, we had exactly the same thing." She answered, "You did not know enough about your work, to know that you were right."

That lesson is brought out day after day in this system. Sometimes, after all answers have been given, instead of asking those with the right answer to get up, I ask those with one of the wrong answers. They stand up with a triumphant look at the others, but most of those who know what is right, look at me with a knowing smile, while a few of them will look puzzled. Those who know they are right do not care which set I ask to stand up, they are not fooled, no matter how I act. This is a little hard on those I ask to stand up, it is a disappointment to them and a little embarrassing, but it is a splendid way of teaching them to rely on their own decisions and very often it catches some unfair pupil who did not have that answer but got up because he thought my method was to ask those with the correct answer to stand. Sometimes, I try to act satisfied when I hear the wrong answer and critical when I hear the right, to see if they are being influenced by my attitude, but those who are on the alert are not disturbed. They are the judges and the jury.

I often give oral examinations by giving twenty questions of

about the same value and marking each 5%. It is a big saver of time, more interesting to the pupil and I think of much more benefit in that he has his wrong impressions corrected immediately. There are a few objections to this—a slow pupil needs more time, a nervous pupil is lost because we call it an examination, and a pupil who judges right and wrong by the way it looks when written would rather write. It is perfectly fair, I think, to let all such take a written examination or come to the teacher and by talking it over, prove he understands. Examinations, I think, should be the privilege of those who want to prove to the teacher that they know more than the teacher thinks they know.

Our home work brings out the practice in writing, that some may think this system would lack. Our writing in class is not so much for a mark as for practice, and this constant daily expression in the briefest and best of English does not lessen their power of writing when they are compelled to take examinations. I find it makes them a little slower in writing in some cases, but so much more accurate and sure, because they take time to think.

Many a time, we pay no attention to marks, not even rising to let me see who have answers. They all sit there, thinking a minute or two on each question, then I give the answer. They have the pleasure of knowing they were correct or the satisfaction of seeing why they were wrong, and without embarrassment to the weak.

To me, this is the strongest point in the system—all are working—all are interested—all are eager to get it right, but satisfied to be corrected. All are in the atmosphere for concentration, all are compelled to do some reasoning and so they form the habit of thinking things out—of relying on conclusions reached in this way and of getting the pleasure out of the power of their own minds, and that to me is the only thing worth while in education.

The mineral bauxite is used on a large scale in the manufacture of the artificial abrasive alundum at Niagara Falls. This abrasive is made in the electric furnace by fusing calcined bauxite. Alundum is particularly efficient in the grinding of steel.—*United States Geological Survey.*

A RULE TO SQUARE NUMBERS MENTALLY.

BY L. C. KARPINSKI,
University of Michigan.

In the January, 1914, issue of SCHOOL SCIENCE AND MATHEMATICS rules were given to square mentally numbers between 25 and 50 and between 75 and 150. The algebraical explanation affords a highly desirable application of the formulas of algebra to arithmetical computation, while at the same time the algebraical statement extends the rule to all numbers between 25 and 150.

To square any number between 25 and 75 find the difference between the given number and 50. This difference subtract from 25 if the given number is under 50, and add it to 25 if the given number is over 50. To the resulting number annex two zeros, and add the square of the difference.

Square 47. Difference 3. Subtract from 25 and annex two zeros, 2200: Add 9, 2209 is the square.

Square 56. Difference 6. 25+6 is 31. 3100+36 is the square. Square 64. Difference 14. 25+14 is 39. 3900+196 is the square.

To do this mentally remember to add the two final numbers from left to right and not from right to left as in written work. Almost all rapid mental calculation proceeds from left to right.

To square any number between 75 and 100, find the difference between the number and 100. Subtract this difference from the given number and annex two zeros. To this number add the square of the difference. A similar rule holds for numbers between 100 and 150.

Square 96. Difference 4. 96—4 is 92. 9200+16 is the square.

Square 86. Difference 14. 86—14 is 72. 7200+196 is the square.

Square 114. Difference 14. 114+14 = 128. 12800+196 is the square.

To square any number between 10 and 20, add the units to the given number and to this sum annex a zero. Add the square of the units. It is always easy to add the two final numbers mentally from left to right.

Square 14. 14+4 is 18. 180+16 is the square.

Square 18. 18+8 is 26. 260+64 is the square.

Only one possible difficulty remains in the numbers between 20 and 25. To square any number between 20 and 30, add the

units to the number and double the result. To this annex a zero and add the square of the units.

Square 24. 24+4 is 28. Doubled, 56. 560+16 is the square.

Any boy who has had just a little algebra will see that these rules are all applications of the simple formulas: $(a+b)^2 = a^2+2ab+b^2$, $(a-b)^2 = a^2-2ab+b^2$, and the teacher of algebra should emphasize this kind of simple application of algebraic formulas.

Thus
$$\begin{aligned}
(50-a)^2 &= 2500-100a+a^2.\\
(50+a)^2 &= 2500+100a+a^2.\\
(100\pm a)^2 &= 10000\pm 200a+a^2.\\
&= 100(100\pm a\pm a)+a^2.\\
(10+a)^2 &= 100+20a+a^2.\\
&= 10(10+a+a)+a^2.
\end{aligned}$$
And
$$\begin{aligned}
(20+a)^2 &= 400+40a+a^2.\\
&= 20(20+a+a)+a^2.
\end{aligned}$$

GRAPHICAL REPRESENTATION OF A GEOMETRICAL SERIES.

By D. H. Richert,

Bethel College, Newton, Kansas.

That a graphical representation of an algebraical expression is of great aid in making clear the full meaning of the problem, is an everyday experience of the mathematics teacher.

One of the difficulties that presents itself to the average high-school student is the conception of the sum of an infinite series (a convergent series, of course).

The following graphical representation of such a series will do much to make it clear to a student that a sum exists in such a case. (Comp. M. Milankovitch, Zeitschr. für Math. u. nat. Unterricht, 40. Jahrgang, S. 329.)

Given the geometrical series,

$$a+ar+ar^2+ar^3+ar^4+\ \ldots,\ r<1,$$

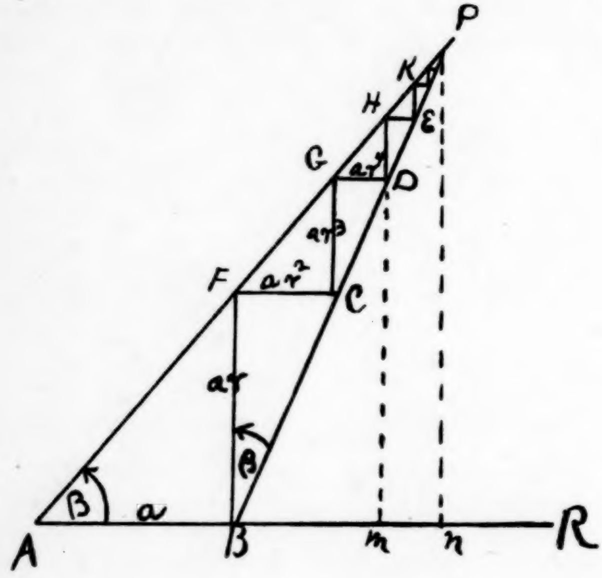
to represent this series graphically.

On the line AR take the distance AB $= a$. Construct at B a perpendicular to AR and make it equal to ar. Construct FC perpendicular to BF at F and make it equal to ar^2. Through A and F draw the line AP, and through B and C draw the line BP.

Between the lines AP and BP draw the broken line CGDHEK . . . making CG, DH, . . . parallel to BF, and GD, HE . . . parallel to FC. Then $\angle$FAB $=$ $\angle$FBC, for $\triangle$ABF

is similar to $\triangle BFC$. Designate these angles as $\angle\beta$, then

$$\tan\beta = r, \text{ and}$$
$$CG = (FC)\tan\beta = ar^2\cdot r = ar^3.$$
$$GD = (CG)\tan\beta = ar^3\cdot r = ar^4.$$
$$DH = (GD)\tan\beta = ar^4\cdot r = ar^5.$$



Hence the sides of the broken line represent, in their order, the terms of a geometrical series, and the sum of the first n terms is represented by the sum of the horizontal and the vertical projections of this broken line.

For example, the sum of the first five terms is

$$a + ar + ar^2 + ar^3 + ar^4 = AM + MD.$$

The sum of the infinitely large number of terms of this convergent series is represented by the lines $AN + NP$.

SILICEOUS EARTHS.

The material commercially called tripoli in the United States is a residue from siliceous limestones which have been leached of their carbonate content. This material is nearly pure silica of very fine grain and may be either coherent or pulverulent. Tripoli is also used as an abrasive material. Diatomaceous earth is largely made up of silica. It is a variety of opal—that is, amorphous silica combined with a small quantity of water. It represents the remains of aquatic plants known as diatoms. Diatomaceous earth, which is also commercially called infusorial earth, kieselguhr, and rarely in the United States, although properly, tripoli, is largely used as an abrasive material.

A HANDY AND AUTOMATIC GAS GENERATOR.

By Theodore Cohen,

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In a previous issue of this journal, April, 1914, appeared an article by the writer entitled, "A Safety Generator for Gases." As was then pointed out, in order to start the reaction it was

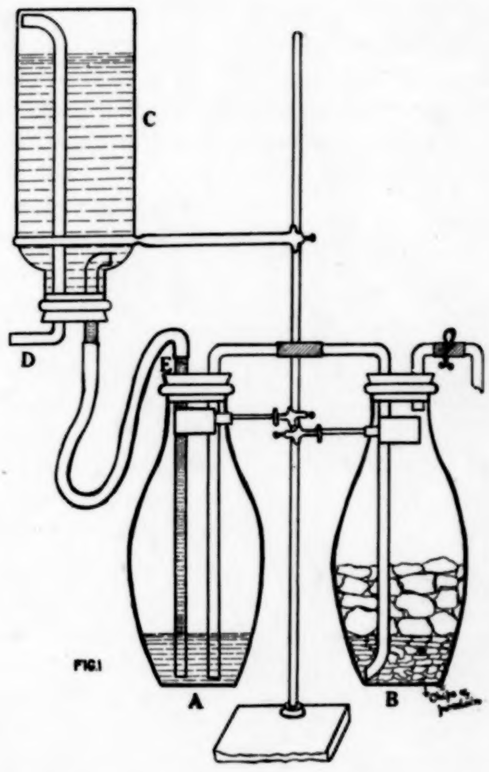

FIG.1

necessary each time to blow into the generator. At the time of publication no suitable scheme was employed whereby to overcome this disadvantage. However, repeated experiments, with the end in view that simplicity and economy be the guiding factors, resulted in a generator which is automatic, readily manipulated, compact, portable and especially adapted to individual student use.

Two gas generating bottles (a) and (b) (common gas collecting

bottles will do just as well) are connected by means of bent glass tubing of about $\frac{1}{4}''$ bore and a piece of rubber tubing, as shown.

To the end of tube (e) is attached a reservoir bottle (c), with tubing bent as shown, by means of a rubber hose ($\frac{1}{4}$ inch bore). The three bottles are held in position by clamps attached to the same ring stand. The clamp attached to the reservoir bottle is free to move for pressure adjustment; in fact a glance at the apparatus will show that the whole system is movable.

Bottle (b) is filled to a depth of about 1 inch with a layer of small pieces of fire-brick (the use of chips of porcelain from discarded crucibles and crucible covers gives a more compact layer) and the material placed above this layer. The stopper is then gradually inserted until the curved glass tube reaches the bottom. With a little care the materials need not be disturbed much thus giving two distinct layers.

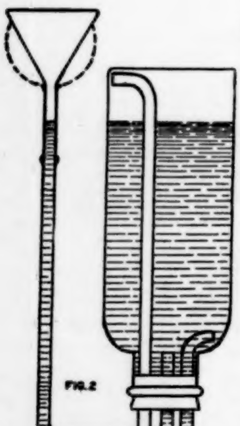

FIG. 2

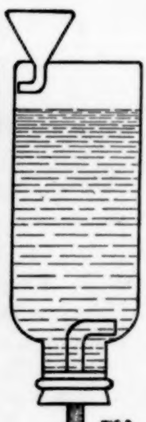

FIG. 3

Place enough dilute acid in bottle (a) so that it will be held by the reservoir (c). The reservoir bottle should preferably be somewhat larger in capacity than the generating bottles. Then blow by means of a rubber tube through (d) to start the acid through the siphon into bottle (b). Closing the pinch-cock drives the acid up into reservoir (c). The generator now works entirely automatically.

Figures 2 and 3 show different types of reservoirs that can be attached to the rubber hose. Figure 2 has an additional hole in the stopper through which passes the thistle-tube or funnel bent as shown, while the reservoir shown in Figure 3 is made by drilling a hole near the circumference of the bottle and inserting a funnel bent as shown. The use of either arrangement permits of filling the reservoir directly and does away with the necessity of blowing the acid over into the generating bottle.

When the acid is all spent detach bottle (a), pour out the contents, replace the bottle and fill again. The use of a Winchester bottle with an opening near the bottom will save detaching.

On closing the pinch-cock should the reservoir hose become

filled with gas instead of liquid as may happen when the reaction is too violent and fail to operate when the pinch-cock is opened, raise the reservoir clamp and acid will flow once more.

To sum up, the unique advantages of this generator are:

1. Little possibility of large pieces of material getting into the reservoir and rapidly diluting the strength of the acid.

2. Rapid change as a generator for one gas to that of another by simply replacing the generating bottle by one that has the proper materials and cleaning connections with water. This can be accomplished in a few minutes.

3. A regulating pressure device by sliding reservoir up and down iron rod.

4. And finally, quickly constructed, portable, cheap, automatic and whose capacity can be readily increased.

CROSS-EYES.

One of the most conspicuous and annoying conditions that may occur in the eyes of a young child is squint, or what is commonly known as "cross-eyes." It occurs chiefly between the ages of 2 and 6 and comes on gradually at first, showing some slight turning inward in one eye, at times, until finally something occurs to precipitate a definite attack and the eye turns in to a greater or less degree and remains so. Frequently a convulsion or an attack of coughing, especially during whooping-cough or some like irritation to the general nervous system, brings on the attack, and is considered by the child's mother to be the cause. This is incorrect. When the eye is turned, it will not look directly at the object at which the other eye is looking, and doubling of the vision is the result. This "doubled vision" is very annoying, as any one may judge for himself by slightly pressing one eye out of position with the fingers. In order to escape this annoyance the child unconsciously stops using the eye that is turned in, and this, in time, leads to changes in the nerve tissues which makes the child's sight defective in that eye. Formerly many physicians advised parents to wait until the child grew older before having anything done to the eye, feeling that an operation was the only thing to relieve the condition, or that the child might "outgrow it." This, in the light of our present knowledge, is bad advice. By the time the child gets to be eight or ten years old the sight in the eye is defective from disuse, and cannot be restored, and this failure of vision has usually occurred even though the eye has straightened itself spontaneously. It is very important, therefore, not to allow the child to stop using the squinting or turning eye. It is not always necessary to operate. Usually glasses have to be worn to stop the strain, and there are other forms of treatment which are many times effective. If these means fail and the eye continues to turn, an operation may have to be done to keep the eye straight and to save the sight in that eye. But not more than half, perhaps even less, will require operation. Fortunately treatment is much more judiciously given and often is more successful now than it used to be, and the present generation of children will probably not show so frequently the defects caused by neglected "cross-eyes."

FACT AND THEORY IN ELEMENTARY CHEMISTRY.

By Ira D. Garard,

High School, Grove City, Pa.

Every teacher of elementary chemistry is confronted with the problem of presenting to the student the simple facts of the science in a logical and systematic way. He must explain the relationship of isolated facts in such a manner that the student may be able to generalize for himself and not be dependent on memory for effects and results, for the encyclopedic method is neither easy nor scientific.

Many difficulties are met with and the subject becomes dry and uninteresting. There are always those students who "never get anything" and then there are those who "get it in spite of the teacher"; but those with whom we are most concerned are the majority who take study as a matter of course and do not attack problems with persistency. These are the students that must be assisted by the instruction of the teacher.

As we look back to the time when we finished our elementary chemistry, we likely recall a hazy jumble of fact and fiction. Atoms seemed as real as metals and chemical action as theoretical as the ether. In fact if we retained any clear conception of chemical fact it was the odor of hydrogen sulphide, the nauseating fumes of nitrogen peroxide, the explosion of an oxyhydrogen mixture, or something else new enough and pronounced enough to impress the senses. Together with these of course, we recall the uses of a few elements or compounds and possibly the explanation of a few everyday phenomena, but we had no clear idea of either the important facts of the science or its importance.

The reason for this condition of students who have completed a year of chemistry seems to me to lie in the failure of text and teacher to keep fact and theory, or hypothesis, separated. It is not uncommon to find ourselves saying that two atoms of hydrogen combine with one of oxygen to form one molecule of water. Again we find ourselves saying that copper sulphate becomes a white powder and loses a certain weight when it is heated because five molecules of water are combined in each molecule of the crystal and these are driven off by the heat. On the other hand we say that if a definite amount of any compound be decomposed, it always yields a definite amount of each element that composes it. In the former case, we were talking theory and in the latter

fact, but we used the same sort of expression in both cases. This gives the student the impression that molecules and atoms of substances are as real as grams or liters of that substance and no amount of drill on the atomic theory as such will serve to disillusionize him.

It seems to me that the remedy for this condition lies in the teaching of fact first and hypothesis later. The student must have the fact and clearly understand it, before he can grasp any explanation of the cause of that fact. To present the atomic theory does not accomplish any definite result. The student may understand its provisions, but he will not see any use for such a theory, unless he first has clearly in mind all of the facts which it endeavors to explain. Some of the more modern textbooks are working toward that end, but most of them are very conservative. The earlier texts presented the atomic theory first and then fitted the subsequent facts into it. Some follow that plan still. Many of them treat oxygen, hydrogen, and possibly chlorine and then the atomic theory just preceding the chemical calculations. This is done to establish a basis for chemical calculations we are told. That is, the student must understand atomic and molecular weight in order to calculate the proportions involved in a reaction. True enough, but let us analyze the situation. We define atomic weight as, "the number which expresses how many times its atom is as heavy as the hydrogen atom," or in some similar terms. Molecular weight, we may define in terms of the oxygen or hydrogen standard or simply call it the sum of the weights of the atoms in the molecules. In either case, the definition is hypothetical and the high school student will ask, "How do you weigh an atom?" This question is almost inevitable from the novice who is always impressed by the description of an atom and the attempt to show how small it must be. Then we go through the process carefully and explain that we do not weigh an atom but that the atomic weight is only a determination of relative weights calculated from vapor densities and the acceptance of Avagadro's hypothesis. This latter assumption is seldom clear to an elementary student and as a result he does not obtain a clear idea of atomic and molecular weights, or if he does he considers them merely theoretical and consequently of little importance. The laboratory work may serve to clear the subject up somewhat, but usually not as well as might be desired for the student cannot associate gram quantities with theoretical numbers.

It seems to me that the most logical course to follow is, as I

stated above, the presentation of fact first. Oxygen and hydrogen may be studied as is customary, but when quantities or compositions are introduced, treat them as the facts which they are. If water be decomposed, nine grams produce eight of oxygen and one of hydrogen; hydrochloric acid produces 1 gram of hydrogen and 35.5 grams of chlorine, etc. These facts are easily grasped by the students. I might say, however, that a danger exists in the unfortunate confusion of the terms—combining weight, reacting weight, equivalent weight, and atomic weight—and some definite meaning for these terms must be followed, preferably the meaning given in the text which is used by the student.

The next step is to generalize from these specific cases of relative weights. Molecular and atomic weights may be introduced, but they must be defined from a fact basis, i. e., one that may be used for a laboratory determination. Some of our physical chemists have defined molecular weight as the weight of 22.4 liters of a gaseous compound under standard conditions, or that weight which will produce an osmotic pressure of 22.4 atmospheres when in one liter of solution. The question of why the number 22.4 was selected, will arise, but may be dismissed as arbitrary except for a historical reason which may be given when the atomic theory is presented later in the course, and even when this is given, it obviously remains arbitrary.

Some crude quantitative vapor density determinations should be made before the class to drive home the idea of actual weights and convey some idea of laboratory methods. The demonstrations of osmotic pressure do not need to be quantitative, but they should show what is meant by osmotic pressure and that it varies with the concentration of the solutions. The student will easily see that the amount of the pressure could be measured.

If we define molecular weight as suggested above, then we may designate the atomic weight as the smallest combining weight of an element ever found in any compound of that element. The method of its calculation may easily be shown, i. e., find the molecular weight of the compound, analyze it for the percentage of constituent elements, and then multiply the former by these percentages. That this gives the combining weights of the elements involved, is obvious. After several examples have been given, we may point out that the smallest combining weight of each element ever found is taken as its atomic weight. This may also be expressed in grams and is still fact.

The terms "atomic weight" and "molecular weight" are not good, but may be explained as of historical origin and having nothing to do with atoms or molecules.

Symbols, formulae, and equations may be used and explained without the aid of any theory. For example H_2O represents one molecular weight of water consisting of two atomic weights of hydrogen and one of oxygen, i. e., 2 grams of hydrogen to every 16 grams of oxygen. Also C_2H_6O represents one molecular weight of alcohol containing two atomic weights of carbon, six of hydrogen, and one of oxygen. Further O_2 is so written because one molecular weight of free oxygen is found to contain two atomic weights, i. e., 22.4 liters weigh 32 grams, while the atomic weight is 16 grams.

Reactions may be similarly treated. For example,

$$CaCO_3 \rightarrow CaO + CO_2$$

simply means that one molecular weight (100 grams) of calcium carbonate, under certain conditions, breaks down and forms one molecular weight (56 grams) of lime and one (44 grams) of carbon dioxide which latter has a volume of 22.4 liters, since it is a gas.

Reactions involving relative gas volumes also submit to this treatment and valency is simplified. We may say that elements have different powers of combining with each other, e. g., one atomic weight of oxygen is found combined with two of hydrogen while one of chlorine unites with only one of hydrogen. So we say that oxygen has a combining power or valence of two, and chlorine has a combining power or valence of one, since hydrogen has been chosen as the arbitrary standard. All calculations may be performed and facts stated in these demonstrable terms as well as in theoretical ones, and the student is not confused as to fact and theory because he has had none of the latter. After he has been drilled in calculations and performed a few quantitative experiments, then we may say that there have been many hypotheses advanced to explain why these facts are true and teach the atomic theory as the best accepted one. It should be emphasized that while all the facts support this theory, it cannot be proved; but the facts and laws are unalterable and cannot be affected by the proof or disproof of any theory.

TO WHAT EXTENT SHOULD BIOLOGY COURSES BE ADAPTED TO THE PUPIL'S IMMEDIATE ENVIRONMENT?

By Jean Dawson,
Normal Training School, Cleveland.

A new definition of education has appeared for our consideration. Not that we are surprised, for who of us has not our pet notion of what an education is and where it can best be obtained? We may even confess at being rash enough at times to break out in print with our ideas.

This definition claims our attention, however, first because it does not use schooling and education as synonymous terms as some of us are unconsciously apt to do. And second because it is so broad and comprehensive that no school or higher institution of learning, as they stand today, could or would claim to educate its students. If they could, one hundred institutions of learning would spring up where there is one now, for according to this definition, no one can lay claim to be educated who does not know how to successfully play the game of life.

Imagine what consternation would paralyze our institutions of learning if they were required to teach their students to play this great game successfully; what changes in the curriculum would take place; what strife for efficiency of mind and body; what a struggle for the upbuilding of character and the acquirement of a pleasing personality and all the other things that go to make up a successful player in life's great game! What pep and ginger would be infused! But pshaw, what is the use of considering learning the game in our school or college when so many of our so-called educators believe that the training that was given to the ancients is and always will be the proper training for us. Imagine the commercial world taking such a stand! We cannot conceive of an up-to-date merchant holding in stock the goods of the ancients when he knows that there is no demand for them on the part of the modern public. Is it not this very attitude that causes the educational world to lag years behind the world of commerce and causes yearly an army of young men and women to leave college without a working idea of how to make their way in the world?

We would drop this idea of education here, but somehow it challenges further thought. After all, is it Utopian? As a matter of fact doesn't every parent cherish the hope when he sends his child to school that somewhere along the line he may gain a

requisite knowledge of the game? Is it not this hope that causes any school to be crowded that lays claim to practical work?

Upon further thought we remember that this view of education is not new. No less an authority than the great Huxley, in his *Essays on Science and Education,* expresses this same idea in classic form.

> "Suppose it were perfectly certain that the life and fortune of every one of us would, one day or other, depend on his winning or losing a game at chess. Don't you think that we should all consider it to be a primary duty to learn at least the names and moves of the pieces; to have a notion of a gambit, and a keen eye for all the means of giving and getting out of check? Do you not think that we should look with a disapprobation amounting to scorn upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?
>
> "Yet it is a very plain and elementary truth that the life, the fortune, and the happiness of every one of us, and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just and patient. But we also know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated—without haste, but without remorse."

But let us now come to the consideration of the title of this paper, "To what extent should biology be adapted to the pupil's immediate environment?" With the above definition of education in mind, should we not adapt the course to its fullest extent to the needs of our pupils? Psychologically, must we not go from the near to the remote, from the known to the unknown? I think that it was Coulter who made the statement some years ago that we must educate through, not in, the environment. This is true, but I would go farther and say that only that which is vital to the life of the individual in any particular environment should be taught.

The time and human energy that the average individual can devote to the subject of biology are so limited that much that is useful and even necessary must be eliminated. We must not use courses in biology that we have taken as a criterion to go by in judging our pupils' needs. Biology with us is vocational. The problem of the teacher in the secondary schools becomes one of selecting that which is vital from that which is merely useful.

Doubtless you may think that I have in mind the teaching of agriculture. By no means. Agriculture is a vocational subject and the teaching of it should be confined to the vocational and technical schools. The biology that I have in mind is a course that every boy and girl should have regardless of vocation, an underlying stratum of knowledge upon which every life is built; essential rules of the game as it were that must be learned by every successful player.

A case in point is the teaching of enough elementary bacteriology to secure an understanding of sanitation and preventative medicine. The student should gain a clear notion of the nature, growth, reproduction and work of germs and have a knowledge of the causes and the means of prevention of all the contagious diseases. For who can become a successful player if his bodily strength is sapped by the ravages of disease germs? It is safe to say that no one of us would think of teaching the details of such remote diseases as scurvy or sleeping sickness when the student is exposed to a dozen or more diseases of his immediate environment, as diphtheria, typhoid fever and tuberculosis.

A class should have the reports of the latest medical researches and keep in close touch with the practical work in the city. Excursions should be taken to school clinics, tubercular exhibits, sanitaria and baby dispensaries. Lectures and demonstrations should be given before the class by members of the board of health, school physicians and members of the associated charities.

The student will come to realize that careful as he may be, he cannot wholly prevent disease germs from entering his body and that he must rely upon the germicidal power of his blood if he would escape disease. With this end in view, he seeks to take the required amount of fresh air, exercise and baths that lead to physical fitness.

Time does not permit this paper to outline a course in biology vital to the needs of the city. I might go on and cite the study of trees, birds and insects corresponding to the above outline on bacteriology. However it is not necessary. Sufficient to say that we as a people do not know our enemies from our friends. We are doing little or nothing to prevent the loss and even extinction of our best friends, birds, toads and bats, arch enemies of insects that destroy millions upon millions of dollars' worth of produce yearly, to say nothing of the toll they take in unknown thousands of human lives.

Our only hope of controlling such insect ravages is to unite the

people in a supreme effort to rid themselves of these pests. This can only be done through the proper education. That the average person will act when he learns the truth is illustrated by the effort that the people of Cleveland have made to rid themselves of the filth-disease fly. Until the past spring when the city took charge of the work of eliminating the fly, the movement was carried on by people led by teachers and pupils in the public schools.

To work out a course of vital biology is no mean task. Unfortunately our colleges and universities where we get our training are doing relatively nothing to equip us with a knowledge of practical biology and we find ourselves thrown upon our own resources.

Biology in the normal school has changed from year to year in the course of its adjustment to the people's needs as we have been able to see the light ahead. For instance, two years ago we learned through a series of tests that our entering pupils were amazingly ignorant of the most common plants, vegetables and trees which, hitherto, we had credited them with knowing. Their powers of discrimination were so feeble that they found it difficult to distinguish a potato from a tomato vine, a willow from a peach leaf, an ash from a hickory, wheat from oats, peas from beans, a cabbage from a turnip, a rose from a blackberry bush.

Now upon entering the school, our first task is to familiarize the pupil with about one hundred specimens of plants. To obviate the difficulty in the future, each outgoing graduate takes to the grade in which she goes to teach about fifty well pressed specimens put up in boxes and covered with glass, under which the plant is spread upon a bed of cotton. These specimens, with names attached, are to be placed in the school-room and the children are invited to go into vacant lots, gardens and by the road side to find plants like them. By this method it is hoped the busy teacher will be enabled to familiarize her pupils with a large number of specimens which they collect themselves and which will cultivate in them the taste for nature study.

In the few minutes left for this paper, perhaps I can show how phases of the work are adjusted and brought into the course. The new work this fall has to do with yards, back and front. While passing through the hamlets, villages and cities in fourteen states, north, south and west of Ohio, this summer, I was greatly impressed by the careless, indifferent, not to say barren and ugly setting of the majority of American homes. I

am not referring to the slums. These homes were inhabited by good average American families who pride themselves upon comfortable interiors with good plumbing and the use of dustless mops and vacuum cleaners. Lawns were ever present, but the modern built houses stood unadorned with no setting of leaves, vines and shrubs to furnish shade and to relieve the glitter of new paint, blistering in the scorching sun. Poverty cannot be offered as an excuse for the multitude of barren unhome-like American dwellings, with their all too often rubbish strewn back yards, and weedy, ill-kept, ill-arranged vegetable and flower gardens, for a dozen varieties of seedling trees, native shrubs, used by the best landscape gardeners, and wild grape vines, woodbine and virgin bower might be had for the trouble of going to the nearest woodlot.

A new civic conscience is needed and may civic improvement clubs spring up everywhere and send a wave of enthusiasm over the land from coast to coast, from Canada to Mexico. The most effective work, however, can be done in the school.

Unfortunately this lack of well planted, well kept yards is not only true of the fourteen states aforementioned, but it is true of our own state and our own city as well. If any of you want to learn just how true it is, do as we have been doing. Go out with your kodak in hand, prepared to take pictures of well planted yards.

One hundred and fifteen young women have been at work on the problem this fall. Each is to describe ten yards that she considers well planted and ten that are in dire need of clothing their ugly walls, fences and sheds with the leaves and branches of trees, shrubs and vines and of rounding out straight lines that nature so abhors. The problem centers about the homes of the masses; the planting about wealthy homes is excluded from this list unless it can be copied with little or no expense.

The girls are enthusiastic; fully one thousand homes have been described and about five hundred pictures taken. One girl pointed out to the class the lack of excuse for so much unadorned ugliness in Cleveland when thousands of trees are given away here yearly, sweet honeysuckle vines sell at the five and ten cent store for ten cents apiece, and rambler rose bushes three for a quarter.

Later in the course these girls will receive instruction on the care of the soil and will be given the simple rules of correct planting. Diagrams of their home grounds with its present

planting will be made, and they will study how they may best be improved. Arrangements have already been made to have the park department give these girls instruction in the propagation of plants, and they will slip, bud and graft under expert direction.

Thus it is hoped that the day will come when cuttings from a favorite shrub or vine may pass from teacher to pupil or from pupil to pupil until even the humblest home in the city may be a picture framed appropriately in trees, vines and shrubs.

RIGIDITY OF THE EARTH.

An experiment to test the rigidity of the earth has been designed by Professor A. A. Michelson, of the University of Chicago, at the instigation of Professor T. C. Chamberlin, of the Department of Geology, and Professor F. R. Moulton, of the Department of Astronomy. The method consisted, briefly, in measuring with microscopes the changes in level at the ends of a column of water 500 feet long, which half filled a pipe 6 inches in diameter placed 6 feet under ground to insure constancy of temperature. The attraction of the sun and moon was found to cause tides in the pipe, which were measured every hour, day and night, for two months under the direction of Professor Henry G. Gale. The maximum changes in level in the 6-inch pipe amounted at each end to about 0.001 inch. Under Professor Moulton's direction these water tides were computed and it was found that they amounted to about seven-tenths only of what they would have been if the earth were absolutely rigid.

To the unscientific mind these facts and figures may seem at first to have but little interest. But when explained the result is little short of startling, since they show that the interior of the earth is not a molten viscous mass, as has been popularly believed, but resists the tidal forces of the moon and sun about as it would if the earth were made of solid steel. Nevertheless the earth in spite of this high rigidity behaves as an elastic body, not liquid, of course, but still subject to the same influences (producing tides) as are the oceans which form part of it.

That the solid surface of the earth is subject to the same ebb and flow as are the tides of the ocean, although to a lesser extent, is a statement that will astonish the average person who is prepared to assert with all the assurance of conviction that the earth is a rigid, immovable body. Nevertheless, the fact that there are tides of about a foot in the surface of the earth has been demonstrated as a scientific fact. This is no more remarkable than is the fact that the earth on which we live is a revolving body, yet because it is a new idea and one only recently established, it is likely to strike the unscientific mind as one of the peculiarities of science.

The scientific presentation of the experiment and its results from an astronomical and geological point of view are given in the March issues of the *Astrophysical Journal* and the *Journal of Geology*, published by the University of Chicago Press.

SOME DATA REGARDING THE TEACHING OF ZOÖLOGY IN SECONDARY SCHOOLS.

By Elliot R. Downing,
School of Education, University of Chicago.

About a year ago a questionaire was sent out to various high schools of neighboring states asking for information regarding the work in science and especially in zoölogy. The work was undertaken primarily to gain experience that would serve in the formulation of an investigation of wider scope which is now under way. But the preliminary results seem of sufficient interest to justify their publication.

This questionaire was sent to the superintendents of schools in the cities of over four thousand inhabitants in the states of Illinois (Chicago excepted), Indiana, Michigan, Wisconsin and for comparison those also in Vermont, Georgia and Washington. A letter accompanied the questionaire asking the superintendent to hand it to the zoölogy teacher with the request that he fill in the answers and return it in the self-addressed and stamped envelope that accompanied each letter. Some three hundred questionaires were sent out and one hundred and twenty were returned.

In seventy-four of the one hundred and twenty high schools returning reports zoölogy is taught. Seventy of the instructors answer the questions quite fully and I wish to express my appreciation of their painstaking coöperation which has enabled me to present this report. The following table indicates the number of replies received from each state and the number of schools in which zoölogy is taught.

State.	No. of replies received.	Zoölogy taught.	Zoölogy not taught.
Georgia	5	0	5
Illinois	32	29	3
Indiana	29	8	21
Michigan	34	24	10
Vermont	2	1	1
Washington	6	4	2
Wisconsin	12	8	4
	120	74	46

The Teacher's Preparation.

Of the seventy teachers who answered the question regarding their preparation forty-two did not study zoölogy in high school, twenty-eight did. Of the latter eight had it for a year, twenty for a half year. The textbooks which they used, so far as remembered, were: Jordan & Heath, *Animal Forms*, 3; Colton,

Practical Zoölogy, 2; Needham, 2; and one each Holder, Kingsley, Kellogg, Orton, Osborn, Packard, Parker's *Biology,* Steel. The author's name only was recalled by eleven; three also gave the title of the text.

Three of the seventy are not high school graduates and do not name any higher institution that they have attended. Four more are not high school graduates but have attended higher institutions entering presumably by examination. Sixty-three are high school graduates. Forty-eight give the year of their graduation and the average is 1901 (-¼) with the extremes 1889 and 1911. Nine out of the thirty-two in Illinois graduated from high schools outside of the state, two out of twenty-nine in Indiana, four out of thirty-four in Michigan, four out of six in Washington and one out of twelve in Wisconsin. Crawfordsville, Indiana and Ann Arbor, Michigan, are the only two high schools from which more than one of these zoölogy teachers came; two came from each of these.

Fifty-six of the seventy are college graduates. Five more attended college but did not graduate. The degrees received are as follows: B. A. 37, B. S. 17, B. L. 2, M. A. 10, M. S. 7. Ph. D. 5, M. D. 2. On the average the year in which the bachelor's degree was received is 1906. Six were 1912 graduates, seven 1911. There are coming to be quite a number of these questionaire investigations of the teaching of the various sciences as indicated in the appended bibliography so that comparisons are possible now. The college preparation as given above is much better than that of similar teachers reported by Caldwell five years ago. Part of the difference may be due to the incompleteness of his returns on this topic but he reports only seven teachers out of forty-nine with degrees. As far as the evidence goes it indicates that the high school is demanding a teacher with appreciably better preparation. And this is evident in so short a period as five years.

Twenty-four out of the seventy teachers reply that zoölogy is their major interest; eight say it is not such without specifying the subject that does interest them most. Thirty-four state the subject as follows: agriculture 3, biology 9, botany 11, chemistry 5, history 2, physics 3, physiography 1, physiology 2.

Conditions of Instruction.

The zoölogy teacher has on an average 5.4 periods to teach per day. The specific numbers are given in the tabulation:

One teaches one period per day (he is the superintendent).
One teaches two periods per day (he is the high school principal).
Seven teach four periods per day.
Twenty-eight teach five periods per day.
Twenty-seven teach six periods per day.
Five teach seven periods per day.
One teaches eight periods per day.

In addition to zoölogy the zoölogy instructor handles botany in 42 cases, physiology 24, physiography 19, physics 14, chemistry 13, history 10, physical geography 7, agriculture 6, biology 6, general science 5, geology 3, algebra 3, English 2, mathematics 2, and in one case each civics, German, commercial geography, psychology. In one case the zoölogy instructor teaches no other subject during the year besides zoölogy, but 18 give instruction in one other subject, 21 in two others, 15 in three, 7 in four, 7 in five and 1 teaches seven other subjects including history and mathematics. It is evident that the student preparing to teach zoölogy in high school needs quite as broad a preparation still as was indicated by Caldwell's results, several years ago.

ORDER OF SCIENCES IN CURRICULUM.

As far as reported in this questionaire the position of the sciences in the curriculum is indicated in the subjoined table:

	1st Year.	2nd Year.	3rd Year.	4th Year.
Agriculture	3	4		
Botany	19	60	2	
Chemistry			49	27
General Science	10			
Physics		1	27	56
Physical Geography	20	6	1	
Physiography	30	9	2	
Physiology	25	7	4	
Zoölogy	14	49	8	1

Main devises a method of calculating a number to indicate the relative position of a subject in the curriculum. He multiplies the number of times the subject occurs in the first year by the factor 0.5, the number of times it occurs in the second year by 1.5, etc. Then he divides the sum of these products by the number of times the subject occurs altogether. I see no advantage in using the fractional factors. I have therefore multiplied the number of times a subject occurs in the first year by one, second year by two, etc., and proceeded otherwise as Main does. I have thus calculated the position of each of six subjects, all the published data will allow, from the figures of Hunter, Weckel and Main for comparison with my own. The results follow:

	Hunter, 1910.	Weckel, 1911.	Main, 1913.	Downing, 1914.
Botany	2.18	1.62	1.95	1.80

	Hunter, 1910	Weckel, 1911	Main, 1913	Downing, 1914
Chemistry	3.53	3.20	3.45	3.37
Physics	3.22	3.28	3.50	3.65
Physical Geography	1.67	1.37	1.25	1.30
Physiology	1.86	1.59	1.44	1.55
Zoölogy	2.18	1.78	2.35	1.94

Weckel does not attempt to reduce the position of the subject to a single term but shows in percentage of the total number of times a subject occurs its proportionate distribution by years. Main's figures are not given so I can not calculate his results in this way but the others are given herewith:

	1st Year. Per Cent.	2nd Year. Per Cent.	3rd Year. Per Cent.	4th Year. Per Cent.
Botany:				
Hunter	32	42	11	13
Weckel	43	40	9	3
Downing	23	60	2	
Chemistry:				
Hunter	1	3	38	58
Weckel			68	29
Downing			65	35
Physics:				
Hunter	1	9	56	34
Weckel		5	50	42
Downing			33	66
Physical Geography:				
Hunter	57	30	3	10
Weckel	62	20	5	5
Downing	74	22	4	
Physiology:				
Hunter	54	18	10	18
Weckel	46	26	11	7
Downing	67	18	10	5
Zoölogy:				
Hunter	18	56	16	10
Weckel	13	63	13	
Downing	19	69	11	1

It will be noted perhaps that the sum of the per cents for the four years does not always make 100%. The discrepancy is due to the fact that not infrequently a subject will be offered as an elective in any one of two or three years.

It would seem from the first of these tables that there is practical unanimity of opinion as to the sequence of these six subjects at least, for the order is the same in each of the four investigations, 1 physical geography, 2 physiology, 3 botany, 4 zoölogy, 5 chemistry, 6 physics, except that Hunter's figures indicate a reversal of the last two. When the second table is examined it is evident that the unanimity is apparent in the first rather than real. A comparison of the per cents in the second table would

seem to justify the conclusion that the sciences are tending more and more to be fixed in certain years. In every case my figures show a larger per cent in one year than do those of Hunter and Weckel except in chemistry where Weckel has 68% in the third year against my 65%. In half the subjects that progress toward concentration of a subject in a given year is fairly uniform. Thus in physics, the increasing tendency to put it in the fourth year is shown by the per cents 34, 42, 66 and its simultaneous decline in the third year by 56, 50, 33.

Yet in every case the subject appears in nearly every year with a considerable per cent. It is very natural for a teacher who has specialized in a given subject to desire to have the other subjects presented first. In his mind they contribute to an understanding of his special interest. There is evidently no logical sequence of subjects so apparent as to be convincing to all. But a sequence with dependent continuity is eminently desirable. It is a weakness of the high school science that it consists of independent units instead of being a coherent whole as are the classics. A student must take his Latin in a definite order and each term's new work is built on all that has preceded. He must hold in mind a deal that he has learned. And this increasing complexity of the subject matter, commensurate with the increasing mental capacity of the student is one of the best features of a school subject from an educational point of view. It will be a very desirable achievement when we shall have subordinated individual preferences to some unified scheme so that teachers in their preparation and authors in the formulation of their textbooks may be reasonably certain of the preparation a student will bring to a given subject. It would seem as if the fundamental concepts of physiography, biology, physics and chemistry might be presented in a first year science course with sufficient clearness so as to render them serviceable in the latter specific courses. Thus the biologist would like to have chemistry and physics precede his subject so he could use their material in the study of biological phenomena. The chemist would be glad to have biology and physics given before chemistry. Evidently these desires are not all possible since they are conflicting. It remains to be seen in how far the general science of the first year can satisfy them. The tables indicate apparently with unanimity that the science work of the second year should be biological in its content. Chemistry is evidently settling into the third year and physics into the fourth. Agricul-

ture and domestic science are too recently introduced to have gravitated into their permanent positions.

It is doubtful if, country over, we shall ever agree on a perfectly uniform order for the science subjects; it would be unwise if possible. It is important, however, that we agree to make the science work sequential, no matter what the order of subjects. That is a task the accomplishment of which must be the joint work of the administrative officer and the science teacher. The former must stop using the science subjects as "fillers" to fit into unoccupied chinks in the student's programs to suit his convenience. The latter must select the subject matter and the textbooks so as to insure coherency. He must organize the material in his own mind with care and hold his students to the constant use of what has already been learned in the attack on the problems presented in the more advanced subjects. This demands on the part of the college student who is preparing to teach a prevision and appreciation of pedagogical problems he is not likely either to possess or early acquire unless the college itself will recognize that there are problems in science teaching other than mere knowledge of subject matter and will offer a course in its organization.

METHODS.

The following tabulation shows the text books used in so far as reported:

	Number of schools.
Linville and Kelly, *Textbook in General Zoölogy*	29
Colton, *Descriptive and Practical Zoölogy*	8
Jordan, Kellogg and Heath, *Animal Studies*	8
Hunter, *Biology*	4
Jordan and Kellogg, *Animal Life*	4
Kellogg, *Animals and Man*	4
Kellogg, *Elementary Zoölogy*	4
Herrick, *Textbook in General Zoölogy*	3
Davenport, *Introduction to Zoölogy*	2
Bailey and Coleman, *Biology*	2
	70

The length of the recitation periods is given as follows:

Eighteen schools report 40-minute recitations.
Forty-eight schools report 45-minute recitations.
Three schools report 50-minute recitations.
One school reports 55-minute recitations.

The laboratory period is given as indicated in the table below:

Five schools report 40-minute periods.
Fifteen schools report 45-minute periods.
One school reports 55-minute periods.

Thirteen schools report 80-minute periods.
Thirty-five schools report 90-minute periods.
One school reports 100-minute periods.
Thirteen schools report one laboratory period per week.
Forty-three schools report two laboratory periods per week.
Eight schools report three laboratory periods per week.
Two schools report four laboratory periods per week.
Four schools report five laboratory periods per week.

The actual amount of time devoted to laboratory work per week varies from forty minutes to 450 minutes. Twenty-three schools each give 180 minutes to the laboratory exercises, nine give 160, twelve give 90. The practice of the other schools is so lacking in uniformity that there are scarcely any other two schools that have the same length of time.

One of the suggested improvements desired by the teachers who replied to Caldwell's questionaire was greater opportunity for field work. This desire is apparently being realized. The reports now are indicated herewith:

Seven schools report simply "Field trips are taken."
Four schools report "Very few field trips."
One reports "Few."
One reports "They are given twice a week."
Three schools report "Field trips often."
Ten schools report "Five or six during the course."
Four report them as monthly events.
Six report "Weekly field trips."
Four report "Twice a week."
Six only report them as not occurring.

Aims.

Sixty-one of the teachers expressed their aims in teaching the subject. In many cases more than one purpose was stated by a single person. The following tabulation will show the number of times each sort of aim was mentioned:

Practical 31
This includes such expressions as:
"The practical side should have emphasis."
"To teach the economic value of animals."
"A general knowledge of economic zoölogy."
Vocational (included above) 1
Observation 20
"To teach pupils to observe rightly."
"To train the eye."
"To train in habits of observation."
Scientific Thinking 16
"To develop a scientific attitude of mind."
"To awaken a scientific spirit."
To impart knowledge of animals and give information on biology..... 40
These "knowledge" aims may be subdivided as:

"To increase knowledge"	8
"Cultural training"	1
"Familiarity with animal life"	11
"Knowledge of the *structure* of animals"	4
"Knowledge of functions"	2
"General idea of the animal kingdom"	4
"A representative of each group should be studied"	4
"To teach some sort of classification of animals"	3
"To give general idea of evolution"	3
"To arouse *interest* in animal life"	14
"To give an *appreciation* of animals (or nature)"	6
The aesthetic aim	2
"To open pupils' eyes to the beauty of animals."	
The moral aim	8
"To teach honesty."	
"To teach self respect."	
"To teach that nature is governed by law."	
To prepare for physiology	11
To prepare for hygiene	5
To prepare for eugenics	2
To give foundation for college zoölogy	1
	157

The dissimilarity in the forms of the questions asked probably make any comparison between these results and those of Hunter and Caldwell of little significance. Hunter finds that in his returns the utilitarian aim is stressed in 43% of the cases, Caldwell 25%, my results 19%. Scientific training has the emphasis in 30, 36 and 22 per cent of the answers respectively. The love and knowledge of nature for its own sake is the important aim in 49% of Caldwell's answers, in 36% of mine.

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LEADS IN SAND-LIME BRICK.

Michigan has been the leading state in number of plants and in value of production of sand-lime brick since the beginning of the industry in this country, except in one year, 1906. Twelve plants were in operation in the state in 1913, according to the United States Geological Survey. Michigan's product in 1913 was valued at more than twice as much as that of the second state, New York, and represented over 25 per cent of the total value.

PRELIMINARY REPORT OF THE BIOLOGY SUB-COMMITTEE (ON REORGANIZATION OF SECONDARY EDUCATION) OF THE NATIONAL EDUCATION ASSOCIATION.[1]

A. Organization of the Sub-Committee.

In the autumn of 1913, Chairman Orr of the Committee on Natural Science appointed the undersigned sub-committee of seventeen to suggest the aims, the content, and desirable methods of instruction in secondary school biology. The committee as now organized consists of ten high school teachers, three college or university professors, three normal school instructors, and one physician. The geographical distribution of the committee membership is as follows: five members from New York and vicinity, five from Chicago and vicinity, three from New England, and four from the Pacific coast.

During the past winter and spring seven meetings of the committee have been held in New York City, and the Chicago, the New England, and the Pacific coast groups have had several conferences of their group members. As the outcome of all these meetings the committee begs leave to submit this preliminary report, in the hope that it will stimulate a great deal of discussion and constructive criticism.

B. Fundamental Principles.

The committee maintains that *unity of subject matter in any course in science is of first importance,* by which is meant that the subject matter should be so organized that appreciation of *underlying principles* shall form the foundation of the student's knowledge, thus giving him a scientific basis for the organization of his knowledge.

The committee unanimously agrees that a course in elementary science should include a study of the physical environment of living things; and a consideration of plants, animals, and man as living organisms; and that throughout the course constant reference should be made to the application of science to human welfare and convenience.

C. How We Would Plan the Work.

The committee unanimously agrees that *two years of work in elementary science* should be the basis for the more advanced

[1]Read by the chairman at the St. Paul meeting of the National Education Association, July 9, 1914, and later modified by majority vote of committee.

courses in science. Such work should deal with physical environment (including a study of matter and forces), plants, animals (including man), and the general applications of scientific principles to human welfare. If, however, administrative conditions make a two-year course out of the question, we recommend a first year course required of all, and a second year elective.

D. What We Believe Should be Taught.

We maintain that the aim in teaching elementary science should be (1) to train the pupil in observation and reasoning; (2) to acquaint him with his environment and with the common forms of plant and animal life, and especially with the structure, functions, and care of his own body, together with the general biological principles derived from this study; and (3) to show him his place in nature and his share of responsibility for the present and future of human society.

Our general ideas as to content of such a course are stated in Appendixes A, B, C, and D. From these lists of topics it ought to be possible for teachers in rural communities, or in towns, or in large city high schools to prepare an outline of work adapted to the given conditions. In the final report several combinations of topics that have proved satisfactory in typical high schools will be presented.

It will be evident to any one who looks over these lists of topics that in our judgment *human welfare* is the motive that should underlie all elementary instruction in science. While we believe that the *principles of reproduction* should form a part of every course in biology, we do not believe that formal instruction in *sex hygiene* should be compulsory in the class room.

E. How We Would Teach the Subject.

We do not believe in rigidity of method in science instruction. Quizzes, conferences, experiments, individual reports, excursions, text-assignments are all good. They offer a rich and varied choice of pedagogical method and each teacher should be given freedom to develop the methods best adapted to his own group of students and to the environment of the school in which he is teaching.

In the laboratory work time should not be wasted in detailed microscopical work, in complicated experimentation, in useless attention to drawing or other "busy work." All laboratory work should be based on definite information ungrudgingly (and interestingly) furnished, and should be in the nature of a direct effort

to acquire more knowledge at first hand. Experiments, results, and conclusions should be accurately recorded. Neatness in notebook records is desirable, but must not be exalted above thinking or understanding.

Appendix A.

Physical Environment.

The preparation of an outline for teaching the part of the course in elementary science which deals with the matter and forces of the physical environment, together with the general applications of the principles of science to human welfare and convenience awaits the coöperation of the other sub-committees in the sciences. For it is our hope that in the near future all the science committees of the National Education Association will unite and contribute of their best thought in constructing a course in elementary science so full of promise that no school can afford to omit the teaching of its universal principles.

Appendix B.

Plants.

I. Introductory.

1. Inventory of knowledge about plants already possessed by students. Motives for further study. Consideration of the method of study.

2. The general relations of plants to animals and man. Diversity of form and habitat of plants. Aesthetic as well as economic values of the study.

3. Consideration of the familiar parts of a typical green plant, with functions of these parts.

II. Nutrition (the essentials to be obtained through a study of the following organs—details of external and internal structure to be presented only so far as is necessary to an understanding of the functions of the organs).

1. Roots—absorption (method and materials absorbed); transmission of absorbed materials; storage of food; anchorage of plant.

2. Stems—upward and downward movement of sap; storage of food; supporting functions of stem; types of stems and their method of growth.

3. Leaves—photosynthesis and the production of the various nutrients; digestion; transpiration; respiration.

4. Review of the nutritive process as a whole in green plants.

5. Nutritive processes in plants that are not green (e. g., bacteria, yeasts, molds, and other fungi).

III. Reproduction (the essentials to be obtained through a study of the following organs—details of external and internal structure to be presented only so far as is necessary to an understanding of the functions of the organs).

1. Flowers—pollination; fertilization; formation of the embryo.

2. Fruits—seed protection; seed dispersal.

3. Seeds—protection and nourishment of the embryo; seed dispersal; germination of seeds, with review of the nutritive processes involved.

IV. Applications of plant biology to human welfare.

(Topics to be listed in final report.)

V. Survey of plant groups and plant identifications.

(Topics to be listed in final report.)

Appendix C.

Animals.

I. Animals in general—their structure, classification, distribution, ecological relations. Comparative (gross) anatomy of animals chosen to illustrate the principal branches of the animal kingdom; the types selected for study might well be chosen from the following list: amoeba, hydra, earth-worm, snail or slug, crustacean, insects, fish, frog or salamander, bird. Detailed dissections, if attempted, should be confined to one or two types.

II. Life histories of typical animals (preferably chosen in groups, with several allied forms in each group, so that the types may not appear too sharply isolated. Study of reproductive processes (both asexual and sexual), developmental phenomena, growth, metamorphosis.

III. Response to physical environment; geographical distribution; seasonal occurrence; trophic reactions.

IV. Response to organic environment in particular; competition with other forms; parasitism; symbiosis; economic importance of animals to man.

V. The continuity of life as evidenced in the relation of germplasm to soma; in the known genetic relationship of widely different types of domesticated animals, and the structural affinities observed in other animals; in the paleontological record.

VI. Man's place in nature—historic and economic aspects of human life; family and community life; care of the young; close dependence on a multitude of other kinds of life; geographical distribution; migrations.

VII. Man's opportunity to use his biological knowledge—applications of biology in medicine, sanitation, agriculture, forestry, manufactures; contributions of biology to investigations of the mechanics of flight, production of light; methods of investigation; organization of experiments; historical examples of research (Redi, Spallanzani, Harvey, Darwin, Mendel, Pasteur, and their epoch-making studies).

Appendix D.

Man.

I. General structure of the human body. Attention should be directed to the similarities and contrasts in the organs of the lower vertebrates and of man calling special attention to those that result from the erect posture of the latter. The characteristics of a half dozen of the most common tissues (e. g., bone, muscle, cartilage, connective tissue, blood and nerve tissue) should be demonstrated, and a few types of human cells (e. g., lining of mouth and blood corpuscles) should be shown under the microscope or with the projection lantern.

II. Physiology.

A. Nutrition.

1. Food and diet—sources of common animal and vegetable foods; the different nutrients present in a few staple foods; uses of each nutrient.
2. Preparation of food for use by the cells; digestion and absorption in the mouth, in the stomach, and in the intestines.
3. Oxygen supply of the cells; necessity of oxygen for the release of energy; adaptations of air passages, lungs, skeleton, and muscles for supplying oxygen to the blood.
4. Distribution of food and oxygen to the cells; composition of the blood; general course of blood through the body; functions of heart, arteries, capillaries, and veins; composition and use of lymph; exchange of materials between tissues and blood.
5. Uses of materials in the cells.

6. Removal of wastes from the cells and from the body.

B. Functions of the tissues.

1. The skeleton—its use as a framework, as a protection for organs; its use in movement.
2. The muscles as organs for activity; position and action of two or three typical muscles.
3. The nervous system—position, parts, and functions of brain, spinal cord, and nerves; importance of habit; sensations of taste, touch, smell, sight, hearing.
4. Internal secretions and their functions (hormones and ductless glands, e. g., thyroid and thymus).

III. Hygienic care of the body.

1. Healthful diets; economy in the choice of foods; hygienic care and preparation of foods.
2. Alcohol, tobacco, opium, cocaine, and other drugs and patent medicines—danger in the use of these substances.
3. Importance of regularity in removal of refuse from intestines and bladder; prevention of constipation.
4. Exercise in relation to the health and development of the body; necessity for rest; varied activity as a means of rest.
5. Clothing and its relation to health.
6. Cleanliness of the body.
7. First aid to the injured.
8. Hygiene of eyes, ears, nose, and throat.

IV. Bacteria and sanitation.

1. General characteristics of bacteria—distribution, form, size; reproduction and conditions favorable and unfavorable for growth.
2. Economic and sanitary measures based on knowledge of bacteria (e. g., food preservation, soil inoculation, prevention of disease).
3. Prevention of disease by the individual.
   a. Fresh air; pure foods, pure water; healthful exercise; sufficient sleep.
   b. Cleanly habits at home and in public places; dangers of dust; proper methods of sweeping and dusting; care of home premises and of foods; treatment of wounds; coöperation with civic authorities.

4. Prevention of disease by civic authorities.
   a. Care of streets, public places, water supply, sewerage, and drainage; supervision of milk and of other foods.
   b. Methods of securing immunity; quarantine; disinfection.

Appendix E.

Further Suggestions as to Methods in Biological Study.

In outlining this report the committee is aware that some schools may prefer to conduct half year or even whole year courses in botany, in zoölogy, and in human physiology and hygiene. The committee believes, however, that the outlines suggested above are sufficiently elastic and inclusive to provide for these varying needs of the introductory courses in biology. We are confident, also, that there will be an increasing demand for full year biology electives in the later years of the high school curriculum, in which the morphological and evolutionary aspects of the subject may well be given considerable emphasis.

The laboratory method in science was such an emancipation from the old time bookish slavery of pre-laboratory days that many teachers have been inclined to overdo it and subject themselves to a new slavery. It should never be forgotten that the laboratory is simply a means to an end—that the dominant aim in all laboratory instruction should be a consistent chain of ideas which the laboratory may serve to elucidate. When, however, the laboratory assumes the first place, and other phases of the course are made explanàtory to it, the attitude is fundamentally wrong. The question is not what *types* may be taken up in the laboratory to be fitted into the general scheme afterwards, but what *ideas* are most worth while to be worked out and developed in the laboratory, if that happens to be the best way of doing it; or if not, some other way should be adopted with perfect freedom.

Too often our study of an animal or of a plant takes the easiest rather than the most illuminating path. What is easier, for instance, particularly with large classes of restless pupils who apparently need to be kept in a condition of uniform occupation, than to kill a supply of animals, preferably as nearly alike as possible, and set the pupils to work drawing the dead remains? This method is often supplemented by a series of questions concerning the remains which are sure to keep the pupils

busy a while longer, perhaps until the bell strikes—questions usually so planned as to anticipate any ideas that might naturally crop up in the pupil's mind during the drawing exercise.

Such an abuse of the laboratory idea is all wrong and should be avoided. The ideal biological laboratory is only a reasonably good substitute for out-of-doors. Any course in biology, however, that can be confined within four walls, even if these walls be those of a modern, well-equipped laboratory, is in some measure a failure. Living things, to be appreciated and correctly interpreted, must be seen and studied in the open where they will be encountered in life. The place where an animal or plant is found is just as important a characteristic as its shape or function. Impossible field excursions with large classes within school hours, which only bring confusion to inflexible school programs, are not necessary to accomplish this result. Properly administered, the laboratory is doubtless one of the most efficient devices for developing biological ideas; but the laboratory should be kept in its proper relation to the other means at our disposal, and never be allowed to degenerate either into a place for vacuous drawing exercises or a biological morgue where dead remains are viewed.

The committee is unanimous that the work in human biology should be closely correlated with plant and animal biology, and that emphasis should continually be laid on personal hygiene and sanitation. Details of structure and anatomical terms should, therefore, be given only when they are needed for an understanding of the given function or for correlation with other parts of the course. It should be understood that while the topics in hygiene and sanitation for convenience are grouped together in the suggested content (above), in framing a course these various topics should be taught in connection with the various physiological functions with which they are most closely associated.

To present the various topics most effectively, a manikin and a human skeleton should be available. If, however, this is impossible, charts, pictures, and blackboard diagrams should be freely used. Bones, joints, hearts, lungs, and other organs available in a butcher's shop should be employed for demonstration. The student should always be led, however, to refer the various functions and hygienic applications to his own body, and care should be taken to see that few experiments are performed that do not have possibilities of this practical nature.

To illustrate methods that might well be employed in biological

instruction, a few of the topics will later be outlined in detail. The final report will contain suggestions as to better methods of training teachers of biology. The committee plans also to submit a list of apparatus, charts, chemicals, and reliable books of reference that in their experience have been found useful.

During the present year the Biology Sub-Committee is planning to supplement its preliminary report by compiling for the use of teachers information along the following lines:

A. SYLLABI of courses in biology which have proved successful. Each syllabus should be accompanied by a clear statement of what it aims to accomplish, with reasons for believing that it does accomplish these ends.

B. SPECIAL EXPERIMENTS in teaching-methods, covering separate phases of biology teaching. Under this head, send only results which have been strikingly successful.

C. MATERIALS which have been successfully used for illustration or experiment. We wish to discover to what extent the use of home-made apparatus can develop interest in experimentation.

D. PLANS FOR CO-OPERATIVE OBSERVATION among the students, either at home or in school.

E. TITLES OF REFERENCE BOOKS OR TEXTBOOKS of particular value.

Each member of the committee will be glad to receive all possible information on these points from teachers in his locality, and will send it to the chairman at an early date. Please send reports as soon as possible to one of the following:

JAMES EDWARD PEABODY, *Chairman,* Morris High School, New York City.

DR. EDNA BAILEY, 1720 La Loma Avenue, Berkeley, Cal.

DR. THOMAS SPEES CARRINGTON, United Charities Building, New York City.

DR. GRACE C. COOLEY, East Side Commercial and Manual Training High School, Newark, N. J.

DR. JOHN G. COULTER, Box 235, Bloomington, Illinois.

DR. WALTER HOLLIS EDDY, High School of Commerce, New York City.

DR. J. C. ELDER, High School, San Jose, Cal.

WILLIAM L. W. FIELD, Milton Academy, Milton, Mass.

DR. LEROY H. HARVEY, State Normal School, Kalamazoo, Michigan.

DR. CHAS. H. KOFOID, University of California, Berkeley, Cal.

Dr. George H. Parker, Harvard University, Cambridge, Mass.
Miss Mabel Peirson, High School, Pasadena, Cal.
Miss Lillian Belle Sage, Washington Irving High School, New York City.
Harold B. Shinn, Carl Schurz High School, Chicago, Ill.
Ernest S. Tillman, High School, Hammond, Ind.
Dr. Fred Ullrich, State Normal School, Platteville, Wis.
Dr. Herbert E. Walter, Brown University, Providence, R. I.

CYTOLOGY OF SEX.

By Lester W. Sharp.
University of Chicago.

(Abstract.)

We have to deal with the following questions: What visible things are there in the cell which will help us in any way toward an explanation of the phenomena of heredity and sex? If such things are present, what light do they throw on the question of artificial control of sex?

That the chromosomes, of all the organs of the cell, are the most closely concerned in heredity has been rendered highly probable by the work of many investigators. The other parts of the cell are not sufficiently well known to warrant definite statements with regard to them. There is good reason to believe that the chromosomes possess a genetic continuity through an indefinite series of cell generations.

A consideration of the history of the chromosomes in the normal life cycle of animals and plants, especially those forms in which the chromosomes have characteristic size differences, brings to light these facts: (1) Each parent furnishes the offspring with a set of chromosomes. (2) The members of each pair of chromosomes which conjugate and separate at the reduction division come one from each parent. (3) They seem to be homologous in some way; they correspond in visible characters, and the inference from breeding experiments is that they are homologous in hereditary value.

There is a parallelism between the distribution of the chromosomes and the distribution of Mendelian characters, which has led to the conclusion that the former are intimately concerned in the transmission of the latter.

With regard to sex, cytological studies on many animals in-

cluding man have shown, at least in these cases, that: (1) There are two kinds of spermatozoa, differing in their chromatin content and sometimes visibly in size, but only one kind of egg. The sex of the offspring depends upon which kind of spermatozoon fertilizes the egg. It is probable that the converse is true in other cases. (2) Sex is definitely related to certain chromosomes, as has been inferred for other characters, but the nature of this relation is as yet obscure. (3) In the light of these facts it appears to be extremely improbable that we shall ever be able to predetermine the sex of the offspring.

From cytological studies we may draw these conclusions for diœcious organisms: (1) There is a definite relation between the constitution of the germ cell and the character of the adult. (2) The male and the female differ in all the body cells. (3) Sex is definitely determined at the moment of fertilization and is not alterable thereafter. (4) External agents can be expected to influence sex only if they interfere with the cytological processes at the critical periods of reproduction and fertilization.

LUMBERING INDUSTRY OF THE PHILIPPINES.

There are some 60,000 square miles of timber standing in the Philippines, of which two-thirds is virgin forest, according to a pamphlet, *Lumbering Industry of the Philippines*, just issued by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, as No. 88 of its Special Agents Series. The commercial output of lumber has been steadily increasing and has practically quadrupled in the last seven years, amounting to over 112,000,000 board feet in 1913.

Although the hardwood products of the Philippine forests rank with the best in the world for cabinetwork, construction, and various uses in which durability is an essential factor, very little of the yearly output has reached the outside world, as the home demand is more than sufficient to absorb the whole present supply. The industry is capable of very great expansion, acccording to those now engaged in the business. The Director of Forestry estimates the amount of timber that could be removed annually without diminishing the productivity of the forests at ten times the present output. Capital is the principal factor necessary to develop the industry.

American sawmill and woodworking machinery will find a promising market as the lumbering industry develops, according to the publication. In general the American machinery so far used has been very well liked, and nearly all sawmill and woodworking machinery now imported comes from the United States. About the same kind of equipment for sawmills as is used in the United States is in demand, but band-saws and solid-tooth circular saws, although more efficient, can be used but little because of the class of labor available and the difficulty of making repairs.

The pubication is on sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., for five cents.

THE BED, ITS EQUIPMENT AND CARE.

By Minna C. Denton,
Ohio State University.

(The first four topics in this series were outlined in October School Science, the second four in the November number. Continuation in future numbers.

The series is offered as a contribution of material suitable for courses in House Decoration and Furnishing, Home Nursing, Household Management, Home Sanitation, or Housewifery. Lack of school equipment need not prove an insurmountable obstacle; it is usually possible to borrow for the occasion, from private homes or from shops, most of the materials needed.)

IX. Blankets, quilts, comforts. Most efficient means of securing dead air space to conserve heat of sleeper's body. Evils consequent on accustoming sleeper to heavy or too warm covers; as, lowering of body's power to react to temperature changes, with ultimate lessening of resistance to infection.

Respective merits of each sort of cover with regard to comfort of sleeper (heaviness, or weight in proportion to warmth afforded), durability, esthetic possibilities, sanitary qualities (tendency to show soil or absorb moisture, ease with which they may be cleaned, degree to which cleaning process may affect serviceability).

Advisability of separating and finishing separately, the halves of double blankets, for convenience in handling. Most desirable mixtures of cotton and wool for maximum efficiency in blankets. Cost.

Covering of padded cotton, wool or eiderdown comfort with detachable facing of washable material at top to protect it from contact with sleeper's body.

X. Counterpanes, bedspreads. Woven counterpanes; dimity spreads (or similar light-weight close material not wrinkling easily); those exhibiting different sorts of "fancy work" or color schemes; fancy patchwork, quilts. Desirability of each from standpoint of esthetic demands and justification; ease in handling, care, disposal at night, laundering or cleaning; amount of protection from dust, from contact with sleeper, from any soilage which the outer cover affords to blankets or comforts during day and at night—an important consideration; comfort of sleeper (weight of cover, an especially important item in case of sickness); amount of labor invested in the making; money cost;

possibility of utilizing household by-products (dressmakers' scraps, etc.)

Note German method of enclosing blankets (or feather bed used for covering!) completely in washable slip, as sanitary protection of less easily washed portions of bed coverings.

HOUSEHOLD MANAGEMENT IN THE HIGH SCHOOL.[1]

By Bernice Allen,
University High, University of Chicago.

Last year was my first experience in teaching Household Management to high school girls. The class met for single periods (45 minutes) every day for one semester. Our class room was a cooking laboratory.

In planning the course, I realized I would deal with a class of girls which would have had practically no experience with household affairs, and moreover, who had not yet reached the age when they thought it necessary they should know about such matters. Since there were no prerequisites to the course the foundation upon which to build was very uncertain. Thinking that each girl's experience would be sufficient for her to know that preparation of food and cleaning were two large factors in household operations, I decided to group my ideas around these two lines of activity, keeping in mind at all times their scientific, economic and civic aspects, and considering the relative values of the different household activities.

When the class assembled, I found that the girls had very vague notions of what the course ought to teach them. However, several expressed a desire to know how to plan meals and to know what balanced meals were. According to the girl's ideas of how much ought to be spent per day for herself for raw food material, and for food which she thought would nourish her sufficiently, the lowest estimate was 50c, the highest $1.00.

Thereupon followed a study of what foods are; what they contain; what they cost; what calories are; how many calories a day's rations should contain. Then came questions asking how much carbohydrate, protein, etc., should these menus contain? What were the consequences if menus contained too much carbohydrate or too much protein? These and other questions

[1]Read before the Home Economics Section, Central Association, Hyde Park High School, Chicago, Nov. 27, 1914.

carried me farther into the subject than I intended to go, but because of the intelligent interest the girls were displaying and my own curiosity in seeing how far I could take them, I proceeded by the 100 calorie method to teach them to plan menus. Considering the age and size of the girls, I gave them 2500 calories as the approximate number for their day's rations, and asked them to estimate the cost. When the papers were brought in there was considerable distress expressed over the fact that the meals didn't cost enough—the prices ranged from 20c to 50c. Next I asked them to modify their rations to conform to the rule that 10-15% of the calories should be protein. The menu which came the nearest to meeting requirements was placed on the board for criticism. The menu was as follows:

Food	Approx. Amnt. 100 Cal. portion	Price per unit	No. calories	Cost	Protein g.
BREAKFAST					
1 banana	1 large	20c doz.	100	.0160	1.3200
2 eggs—poached	1½	40c doz.	130	.0666	12.614
2 thin slices bread, toasted	1 thick slice	5c loaf	100	.0060	3.600
Butter	1 lb.	40c lb.	50	.0010	0.065
LUNCHEON					
Boiled ham	1 large slice	40c lb.	300	.0936	21.450
Potatoes	1 large	25c pk.	100	.0080	2.690
Macaroni and cheese:					
Macaroni	¼ c.	10c pkg.	100	.0080	3.700
Cheese	1½ in. cube	28c lb.	100	.0140	6.500
Milk	⅝ cup	9c qt.	50	.0066	2.380
Flour	4 lb.	4c lb.	25	.0005	0.793
Butter	1 lb.	....	100	.0020	0.130
Bread	....	....	100	.0060	3.600
Butter	....	....	100	.0020	0.130
Prunes	4	12c lb.	200	.0230	1.400
DINNER					
Lamb chop	⅓ chop	28c lb.	300	.0594	17.580
Peas	⅜ cup	15c can	50	.0215	3.260
Potato	....	....	100	.0080	2.690
Bread	....	....	100	.0060	3.600
Butter	....	....	150	.0030	0.195
Lettuce	2 large heads	10c head	5	.0100	0.314
Olive oil	1 lb.	80c qt.	200	.0330	
Vinegar	½ lb.	30c gal.		.0055	
Custard:					
Milk	....	....	100	.0132	4.760
Egg	....	....	65	.0330	6.307
Sugar	2 lb.	6c lb.	50	.0036	
			2675	.4485	98.078

15 % of 2675 = 401.25.
98.078g.x4 = 392.312 calories of protein.

The menu was prepared and served. A study of the menu and the prepared food brought forth the following criticisms which made me feel that the study had been worth while.

1. The protein although within the 15% limit was rather high.
2. Expensive forms of protein were chosen.
3. A cereal might have been substituted for one of the eggs for breakfast, thus reducing both cost and protein.
4. The amount of ham served was more than one person would care for ordinarily. Considering that both macaroni and cheese contain protein, the ham could be eliminated altogether. Cheese is a cheaper form of protein than meat.
5. That chops are an expensive form of meat but are more easily prepared than other less expensive cuts of meat.
6. A dessert less expensive and less rich in protein might have been selected.

In addition to this study of food where the girl was considering chiefly her own tastes and desires, we made some study of how these same factors—fuel value, cost, etc., were of practical use in institutions and charitable organizations; that such men as Chapin and others had made detailed studies of foods, finding that the minimum price for food which would furnish the requisite amount of energy was from 21c to 25c per day per person.

I will mention a few other things which I tried and which I felt were fairly successful.

After studying heating apparatus and ventilation, the engineer took us around the school building and explained the mechanism of the steam heating system. When studying the water supply we made a trip across the campus to the filtration plant where the water used for drinking purposes at the university is filtered.

As an example of how to economize in expenditures of energy in the kitchen, I asked each girl to make a plan of her kitchen at home. Then I asked for another plan showing how by rearrangement of furniture and equipment a large number of steps might be saved. This problem was not entirely satisfactory because I was not able to see all the kitchens and therefore not able to appreciate all the conditions. Another time I would select some one kitchen and let all work on the same problem.

Some of the topics in which the pupils displayed unusual interest were: 1. Disposal of household wastes. 2. Cleaning agents. 3. The laundry. 4. Scientific management as outlined by Mrs. Fredericks in The New Housekeeping.

SUGGESTIONS FOR FURNISHING A DINING ROOM.

By Harold Le Baron,
New Auburn, N. Y.

I would suggest your using a simple pattern rug of soft green and brown tone; a Brussels rug will always prove a serviceable one for a dining room as it is very easy to keep clean. It will require some looking to get an inoffensive small pattern. The wall paper should be a soft sage green; small two tone stripe is preferable; the woodwork to be ivory keyed to the paper. The curtains should be a plain net or scrim hung apron length. These would probably be about $3.50 a pair if the material were bought and made up. If over-draperies are desired, a small figured tan and green mercerized silk would look very well. These should be shirred at the top with a 1-inch heading, and shirred on a 3-8-inch rod. They should hang perfectly straight and tend to hold the colors of the wall and rug together as much as possible. With brass goods these curtains ought to be made anywhere from $5.00 to $7.00.

With this as a setting, the matter of furniture is largely the taste of the customer. If it were possible, I should put in a perfectly plain set of mahogany of good Sheraton lines, using a dining table, six dining room chairs covered in a dull sage green hair cloth, a buffet (60 inches long at least) and a serving table. A set like this should cost in the neighborhood of $225.00. There are some very nice Sheraton sets, such as I have just described, on the market. Of course you can vary these with inlay and run the price up into the thousands if you wish. There is one thing in particular that you will note, and that is that a china cabinet has not been mentioned. Decorators are eliminating this as fast as possible as commercial show cases are not the proper thing for a home. A cabinet is simply used to display your best glass and china which on state occasions is all removed and leaves your cabinet looking its worst, when it should really be at its best.

With the shell of the room as I described it, almost any furniture of simple design could be used to advantage. The sage green wall paper makes a neutral background for either mahogany or oak. I would advise, however, if you intend using oak not to use the golden oak and mission styles, both of which have become exceedingly common. In case oak is used, it would be better to adhere strictly to a period style throughout for that will always be in good taste.

TEXTILE TESTS FOR HIGH SCHOOL.[1]

By Julia F. Tear,
Hyde Park High School, Chicago.

In the teaching of Domestic Art, the question of "what to teach besides sewing" is a constant problem. In this city and I presume in many others, the question of "what to teach besides cooking" seems to have been more or less definitely answered. The work in cooking has more content and what that content shall be, more definitely determined than in sewing. In endeavoring to give the girls training so that they will acquire a sufficient amount of skill in the technical work of sewing, it is hard not to lose sight of other aims and not to narrow our viewpoint. Many of the girls may be placed in circumstances such that it will not be an economy for them to do a large amount of sewing but all of them must deal with textile materials, not only in choosing their own clothing but in purchasing household materials. The subject of Textiles is so wide and the time that can be spent on it so limited, that what work is given must necessarily be that which will be of the most value to the girl. The information she acquires should have some direct bearing on the life the average girl will live after she leaves school. Some appreciation of good color and good design in textile fabrics is certainly one phase. Another important phase of the subject is the economic aspect. In order to purchase with intelligence, some appreciation of the quality and value of materials is necessary.

In this day with the cleverness of manufacturers in making up poor fibers into attractive but poorly wearing fabrics, it takes an expert to determine the quality of materials with any definite accuracy. Since we can not make textile experts of our pupils in the short time that we have them, what can we teach that will be of greatest value to them?

In order to become intelligent buyers, they must first become familiar with the standard materials. If they learn the look, feel, quality and price of a certain piece of material they will have something by which to judge other pieces of material. To do this one may have the pupils collect the more or less standard materials, learning the width and price of each. This work ought to be connected as far as possible with the sewing being done at that time. In doing this work, such questions as the following, naturally arise: "Is the material worth the price?" and "How can

[1]Read before the Home Economics Section, Central Associations, Hyde Park High School, Chicago, Nov. 27, 1914.

you tell whether or not the material is what it has been represented to be?"

A study of the characteristics of the fibers in their raw and pure state will give the pupils some ability to determine the kinds of fibers in a piece of material. A study of the processes of manufacturing gives an idea of the kinds of adulterations that are possible and also some reasons for the adulterations. When the pupils get some conception of the enormous amount of labor necessary to produce our commonest materials that we demand at low cost, they can see some of the causes that have led to the adulterations now so prevalent on the market.

Since cotton is our commonest material and since the cotton fibers are used to adulterate the more expensive ones, it is well to begin with that. The points they should consider in buying cotton materials and the means of detecting inferior goods are as follows:

1. Cotton material is often heavily sized. When this sizing is washed out, the material has no body and little strength. In muslin, often the sizing can be seen in the interstices of the goods when it is held in front of a strong light. If the material is rubbed hard between the hands, the sizing comes out and this place can be compared as to its body with the material from which the sizing has not been removed.

2. Cotton is often weakened by the bleaching agents used. Goods that has been overbleached tears more readily than the other.

3. Goods that has a high luster, put on by pressing between rollers, is often sold as "Mercerized Cotton." This luster is removed by washing while in genuine "Mercerized Cotton," the luster is permanent.

With linen the adulterations are more complicated and the tests are more difficult. Mrs. Woolman says in her book on "Textiles" that the microscopic test is the only sure test to distinguish between linen and cotton. This test ought to be given to a class, not because they are expected to use it afterward, but by seeing and handling materials that are tested that way they become familiar with the material and have some basis for judging others.

The adulterants used in linen and the means of detecting them are as follows:

1. Sizing; it can be detected in linen in the same way as in cotton.

2. Cotton may be finished to look like linen, or material may have some linen and some cotton threads, this latter being called "Union Goods" which should be priced accordingly.

To detect cotton, the surest test is the microscope—the cotton being twisted fiber while linen is straight.

Another method is to break the threads, ravel out several threads, compare their appearance and their strength. Linen is the glossier, smoother and stronger.

The olive oil test is another simple test. First, sizing must be washed out. Then a drop of olive oil is put on materials to be tested and then blotted. The linen is transparent and the cotton opaque.

The adulterations used in the manufacture of woolen goods are very numerous and difficult to detect. Cotton may be combed in with, and spun with, the wool; or cotton may be used for the warp, or wool may be felted on to a loosely woven cotton foundation.

To detect a warp woof or a foundation of cotton, several threads of warp and woof should be raveled out and carefully examined and broken.

A sure test to detect the presence of cotton is to boil the sample of the material in a five per cent solution of caustic soda for five minutes. All the wool is dissolved, the cotton remaining. If boiled in five per cent solution od sulphuric acid, the cotton will be destroyed and the wool remain.

By testing several samples in this way, the pupils can soon learn what form the adulterations are likely to take. In a large class with no special laboratory conveniences, the teacher will have to do this by demonstrating. With a small class and available equipment, the pupils take an interest in doing this themselves. Perhaps those who take chemistry can test several pieces and give the results to the class.

In silk the common adulterations and methods of detecting them are as follows:

1. The using of inferior fibers such as cotton or linen. The threads may be ravelled out and carefully examined.

2. Weighting with solutions of the salts of tin, lead or zinc. This can be approximately determined by burning a piece of silk. Pure silk is entirely consumed, the weighting remains as ash.

For cotton, linen, wool, and silk materials it is well to give even as a demonstration, the effect of acid, alkali and heat on the fibers and make the application of the effects on each to the processes of laundering and to the removal of stains.

If these tests are carried out in class the girls ought to go out with their interest aroused, their powers of observation increased, and, we hope, more intelligent as purchasers.

PROBLEM DEPARTMENT.

By I. L. Winckler,
Central High School, Cleveland, Ohio.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and solutions will be credited to their authors. Address all communications to I. L. Winckler, 32 Wymore Ave., E. Cleveland, Ohio.

Algebra.

401. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Solve:
$$x^6+y^5 = x^5+y^6. \tag{1}$$
$$x+y = 2. \tag{2}$$

I. *Solution by the proposer.*

Let $x = u+v$, $y = u-v$.

Equation (1) is transformed into
$$2v[6u^5+20u^3v^2+6uv^4] = 2v[5u^4+10u^2v^2+v^4] \tag{3}$$
and equation (2) into $u = 1$.

Substituting $u=1$ into (3) after the removal of $2v$, we have after reduction $5v^4+10v^2+1 = 0$.

$$\therefore \quad v = \pm\tfrac{1}{5}\sqrt{-25\pm10\sqrt{5}}.$$

$$\therefore \quad \begin{cases} x = 1, & 1\pm\tfrac{1}{5}\sqrt{-25\pm10\sqrt{5}}, \\ y = 1, & 1\mp\tfrac{1}{5}\sqrt{-25\pm10\sqrt{5}}, \end{cases}$$

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Equation (1) may be written $(x^6-y^6)-(x^5-y^5) = 0$.

$$\text{or}\,(x-y)\Big[(x^2+xy+y^2)(x^3+y^3)-(x^4+x^2y^2+y^4)-xy(x^2+y^2)\Big] = 0.$$

$$(x-y)\Big[(x^2+xy+y^2)(x^3+y^3)-(x^4+x^2y^2+y^4)-xy(x^2+xy+y^2)+x^2y^2\Big] = 0.$$

$$(x-y)\Big[(x^2+xy+y^2)\Big\{2(x^2-xy+y^2)-(x^2-xy+y^2)-xy\Big\}+x^2y^2\Big] = 0.$$

$$(x-y)\Big[\Big\{(x+y)^2-xy\Big\}\Big\{(x+y)^2-4xy\Big\}+x^2y^2\Big] = 0.$$

$$(x-y)\Big[(4-xy)(4-4xy)+x^2y^2\Big] = 0.$$

$\therefore$ we have the systems $\begin{cases} x-y=0. \\ x+y=2. \end{cases}$ $\quad\begin{cases} 16-20xy+5x^2y^2=0, \\ x+y=2. \end{cases}$

$$\therefore \quad x = \frac{5\pm\sqrt{-25\pm10\sqrt{5}}}{5},\quad y = \frac{5\mp\sqrt{-25\pm10\sqrt{5}}}{5}.$$

Also $x = 1$, $y = 1$.

402. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Find the nth term and the sum of n terms of the series
$$5^2+11^2+19^2+29^2+\ \ldots$$

I. *Solution by R. T. McGregor, Topaz, California, and R. M. Mathews, Riverside, California.*

By the Differential Method:

The first terms of the several orders of differences are 96, 144, 96, 24, 0.

$$\therefore \text{ the } n\text{th term} = 25+96(n-1)+\frac{144(n-1)(n-2)}{\underline{|2}}$$

$$+\frac{96(n-1)(n-2)(n-3)}{\underline{|3}}+\frac{24(n-1)(n-2)(n-3)(n-4)}{\underline{|4}}$$

$$=n^4+6n^3+11n^2+6n+1.$$

The sum of n terms $=25n+\frac{96n(n-1)}{\underline{|2}}+\frac{144n(n-1)(n-2)}{\underline{|3}}$

$$+\frac{96n(n-1)(n-2)(n-3)}{\underline{|4}}+\frac{24n(n-1)(n-2)(n-3)(n-4)}{\underline{|5}}$$

$$=\tfrac{1}{5}(n^5+10n^4+35n^3+50n^2+29n).$$

II. *Solution by Norman Anning, Clayburn, B. C.*

The nth term of 5, 11, 19, 29, . . . is n^2+3n+1.

For by the Method of Differences:

The first terms of the several orders of differences are 5, 6, 2, 0.

$\therefore$ the nth term $=5+6(n-1)+2(n-1)(n-2)/2=n^2+3n+1$.

The nth term of the given series $=(n^2+3n+1)^2=1+6n+11n^2+6n^3+n^4$

$$=1+24n+36n(n-1)+12n(n-1)(n-2)+n(n-1)(n-2)(n-3)$$

$$=1+24\,{}^nC_1+72\,{}^nC_2+72\,{}^nC_3+24\,{}^nC_4.$$

The sum of n terms

$$=n+24\,{}^{n+1}C_2+72\,{}^{n+1}C_3+72\,{}^{n+1}C_4+24\,{}^{n+1}C_5$$

$$=n+12(n+1)n+12(n+1)n(n-1)+3(n+1)n(n-1)(n-2)$$
$$+\tfrac{1}{5}(n+1)n(n-1)(n-2)(n-3)$$

$$=\frac{n}{5}(n^4+10n^3+35n^2+50n+29).$$

Geometry.

403. *Proposed by L. E. Lunn, DeSmet, S. D.*

Given a circle with centre O, the point P, and a line MN. To construct a circle having its centre on MN, passing through P, and tangent to the given circle.

I. *Solution by E. L. Brown, Denver, Colorado, and L. E. A. Ling, La Grange, Ill.*

From P let fall a perpendicular PF on MN and produce it until FG=PF. Through PG describe a circle touching the circle O. This is the required circle.

Describe a circle passing through P, G, and intersecting the given circle in D, E. Join PG, DE, and produce them to meet in R. From R draw a tangent RC to circle O, and through P, G, C, describe a circle. PGC is the required circle.

$DR\cdot RE=PR\cdot RG$; but $DR\cdot RE=\overline{RC}^2$.

$\therefore PR\cdot RG=\overline{RC}^2$.

$\therefore$ CR touches PGC, and it is tangent to CDE. A second tangent from R to circle O may be drawn touching it at X. $\therefore$ a second circle may be described through P, G, C which satisfies the given conditions.

II. *Solution by A. E. Jeffrey, Goshen, Ind.*

Join O with P and using OP as $2c$ and r as $2a$ construct an hyperbola. (See Wentworth's *Geometry*, Section 951.)

The intersections H and H′ of the hyperbola with MN are the centers of the circles that will be tangent to circle O and pass through P.

Proof: The hyperbola is the locus of points whose distances from P and O have the constant difference r $(2a)$.

Therefore $\qquad HO-r=HP,$

i. e., $HI = HP$.

Also $H'O + r = H'P$,

i. e., $H'E = H'P$.

Discussion: No construction is possible if MN is perpendicular to OP and intersects the segment AA′.

One circle is possible if MN is tangent to one branch.

If MN cuts only the branch nearest P, both circles will be externally tangent to the given circle, and if MN cuts only the branch near O both circles will be internally tangent to the given circle.

404. ***Proposed by C. E. Jenkins, Indianapolis, Ind.***

In the triedral angle X—ABC, XD is the bisector of the face angle BXC.

Prove: $\angle AXD \lesseqgtr \frac{1}{2}(\angle AXB + \angle AXC)$ according as $\angle AXD$ is acute, right or obtuse. (From Sander's *Geometry.*)

I. ***Solution by A. E. Breece, Cincinnati, Ohio, and T. C. Cheeseman, Kittanning, Pa.***

(1) Let $\angle AXD$ be acute.

In the plane AXD draw XE making $\angle DXE = \angle AXD$.

Since $\angle BXD = \angle DXC$, $\angle AXD = \angle DXE$ and dihedral $\angle B\text{—}XD\text{—}E$ = dihedral $\angle C\text{—}XD\text{—}A$, $\angle BXE = \angle CXA$. $\angle AXE < \angle AXB + \angle EXB$. $\therefore \angle AXD < \frac{1}{2}(\angle AXB + \angle AXC)$.

(2) Let $\angle AXD$ be a right angle.

Produce AX to E. $\angle BXE = \angle CXA$ as above.

$\angle AXD + \angle EXD = \angle AXB + \angle EXB$. $\therefore \angle AXD = \frac{1}{2}(\angle AXB + \angle AXC)$.

(3) Let $\angle AXD$ be obtuse.

Produce AX to E. $\angle AXD + \angle DXE = \angle AXB + \angle EXB$.

$\angle AXD + \angle DXE = \angle AXC + \angle EXC$.

$\therefore \angle AXD + \angle DXE = \frac{1}{2}\angle AXB + \frac{1}{2}\angle EXB + \frac{1}{2}\angle AXC + \frac{1}{2}\angle EXC$. (a)

$\angle EXD < \frac{1}{2}\angle EXB + \frac{1}{2}\angle EXC$ [by (1)]. (b)

$\therefore$ (a)—(b) gives $\angle AXD > \frac{1}{2}(\angle AXB + \angle AXC)$.

II. ***Solution by Nelson L. Roray, Metuchen, N. J.***

In the triedral angle X—ABC, take $AX = BX = CX = a$, $XD = l$, $AB = m$, $AC = n$, $AD = p$, $\angle AXB = \Phi$, $\angle AXC = \theta$, and $\angle AXD = \alpha$.

Then we have at once

$$\cos\frac{\Phi}{2} = \frac{1}{2a}\sqrt{4a^2 - m^2}, \quad \cos\frac{\theta}{2} = \frac{1}{2a}\sqrt{4a^2 - m^2}.$$

$$\therefore \quad \frac{\Phi}{2} + \frac{\theta}{2} = \cos^{-1}\left[\frac{(4a^2 - m^2)(4a^2 - n^2)}{4a^2} - \frac{mn}{4a^2}\right].$$

Since p is the median of triangle ABC, $p^2 = \frac{1}{2}(m^2 + n^2) - a^2 + l^2$, also $p^2 = a^2 + l^2 - 2al\cos\alpha$.

$$\therefore \alpha = \cos^{-1}\left[\frac{4a^2 - (m^2 + n^2)}{4al}\right].$$

$$\text{If } 4a^2 = m^2 + n^2, \quad \alpha = \frac{\pi}{2}, \text{ likewise } \frac{\Phi}{2} + \frac{\theta}{2}.$$

$$\text{If } 4a^2 > m^2 + n^2, \quad \alpha < \frac{\pi}{2}, \text{ likewise } \frac{\Phi}{2} + \frac{\theta}{2}.$$

$$\text{If } 4a^2 < m^2 + n^2, \quad \alpha > \frac{\pi}{2}, \text{ likewise } \frac{\Phi}{2} + \frac{\theta}{2}.$$

$$\text{Now} \quad \frac{4a^2 - (m^2 + n^2)}{4al} > \frac{\sqrt{4a^2 - m^2}\sqrt{4a^2 - n^2} - mn}{4a^2}.$$

$$\text{Since} \quad \frac{4a^2 - (m^2 + n^2)}{4al} \div \frac{\sqrt{(4a^2 - m^2)(4a^2 - n^2)} - mn}{4a^2}$$

$$=\frac{1}{4al}\left(\sqrt{(4a^2-m^2)(4a^2-n^2)}+mn\right)=\frac{1}{\cos\frac{BXC}{2}}\left(\cos\frac{\Phi}{2}\cos\frac{\theta}{2}+\sin\frac{\Phi}{2}\sin\frac{\theta}{2}\right)$$

$$=\frac{\cos\frac{1}{2}(\Phi-\theta)}{\cos\frac{1}{2}BXC}.$$

But $\frac{\cos\frac{1}{2}(\Phi-\theta)}{\cos\frac{1}{2}BXC}>1$, since $\frac{1}{2}(\Phi-\theta)<\frac{1}{2}BXC$ and $\frac{1}{2}BXC<90°$.

$\therefore\ \cos\alpha>\cos\frac{1}{2}(\Phi+\theta)$.

and $\alpha<\frac{1}{2}(\Phi+\theta)$ when both are acute,

$\alpha>\frac{1}{2}(\Phi+\theta)$ when both are obtuse,

and the theorem is completely proved.

Trigonometry.

405. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If cos A+2 cos C : cos A+2 cos B = sin B : sin C, what is the nature of the triangle?

I. *Solution by Norman Anning, Clayburn, B. C., and the proposer.*

$$\cos A+2\cos C:\cos A+2\cos B=\sin B:\sin C=b:c.$$

Putting in the values of the cosines in terms of the sides,

$$ac(b^2+c^2-a^2)+2c^2(a^2+b^2-c^2)-ab(b^2+c^2-a^2)-2b^2(a^2+c^2-b^2)=0.$$

$$\therefore\quad ac(b^2+c^2-a^2-ab)(b^2+c^2-a^2)+2(b^2-c^2)(b^2+c^2-a^2)=0.$$

Or $$(b^2+c^2-a^2)(b-c)(2b+2c-a)=0.$$

If $b^2+c^2-a^2=0$, the triangle is right angled.

If $b-c=0$, the triangle is isosceles.

If $2b+2c-a=0$, the triangle is impossible.

II. *Solution by T. M. Blakslee, Ames, Iowa.*

From the given proportion:

$$\sin C\cos A+2\cos C\sin C=\sin B\cos A+2\cos B\sin B.$$

$\therefore\ (\sin C-\sin B)\cos A=\sin 2B-\sin 2C$.

This is satisfied by $\angle B=\angle C$ and by $\angle A=90°$.

$\therefore$ angles B and C are either equal or complementary.

CREDIT FOR SOLUTIONS.

396. L. E. Lunn. (1)

401. A. Babbitt, T. M. Blakslee, E. L. Brown, T. C. Cheeseman, R. M. Mathews, A. H. Ritter, Nelson L. Roray, Elmer Schuyler (one incorrect solution). (9)

402. Norman Anning, A. Babbitt, H. W. Brinkman, E. L. Brown, R. T. McGregor, R. M. Mathews, A. H. Ritter, Nelson L. Roray, Elmer Schuyler. (9)

403. E. L. Brown, A. E. Jeffrey, L. E. A. Ling, A. MacNeish, Nelson L. Roray, Elmer Schuyler, Orlo Stearns. (7)

404. A. E. Breece, E. L. Brown, T. C. Cheeseman, Nelson L. Roray, Elmer Schuyler. (5)

405. Norman Anning, A. Babbitt, T. M. Blakslee, E. L. Brown, R. M. Mathews, Nelson L. Roray (2), Elmer Schuyler, James H. Weaver. (9)

Total number of solutions, 40.

PROBLEMS FOR SOLUTION.

Algebra.

416. *Proposed by D. H. Richert, Newton, Kansas.*
Solve: $x^3+x^2-x/3+1=0.$

Geometry.

417. *Proposed by Henry B. Sanders, New York, N. Y.*

If a circle be circumscribed about a triangle, the points in which tangents at the vertices meet the opposite sides lie on the same straight line.

418. *Proposed by H. C. McMillin, Washington, Kansas.*

ABC is a right-angled triangle, B is the right angle, BL is the perpendicular to AC. On the side of BC remote from A, the square BCDE is described, and the line AD cuts BL in M. Prove that $\frac{1}{BM}=\frac{1}{AC}+\frac{1}{BL}$.

419. *Proposed by W. A. Tippie, Troy, Ohio.*

A cylindrical tank is 10 feet in diameter and has ends which are hemispheres of the same diameter. Its total length is 60 feet. If it is lying in a horizontal position, how many gallons of water will be required to fill it to a depth of two feet?

Trigonometry.

420. *Proposed by James H. Weaver, West Chester, Pa.*

If a dodecahedron and an icosahedron are inscribed in the same sphere, the triangular face of the icosahedron and the pentagonal face of the dodecahedron may be inscribed in the same circle.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

Answer serially numbered questions in the following lists:

Princeton University Physics.
Freshman Entrance Examinations, June 19, 1914.

A.—Answer any Five.

1. Define moment of force, work, power.

Prove that when an engine is drawing a train at the rate, V, by exerting a pull, P, the power is P×V.

Describe, and explain, the motions of a man who is hanging by a strap—"a strap-hanger"—in a trolley car which goes rapidly around a corner.

2. The left arm of a balance is a little shorter than the right arm. A dealer, who uses the balance, always puts the object to be weighed in the left pan, and known weights in the right one—who gains, buyer or seller? Why?

Make diagrams of the ordinary suction and force pumps, and point out the difference between the valves in the two. What limits the height to which water may be raised by a simple suction pump? How could you prove it?

3. In what ways may the rate of evaporation of a liquid be increased? When your face is very warm and covered with perspiration, fanning cools it rapidly. Why?

Outline briefly our reasons for believing that heat is a form of energy.

4. Do any two people ever see just the same rainbow? Why?

Use the law of refraction to show, by a diagram, the path of a beam of light through a block of glass with parallel faces, when the light is oblique to the surface of incidence.

What makes the difference between red and blue light?

5. Why do we believe that sound is always produced by the vibration of some material body?

Describe any method for determining the value of the velocity of sound in air. How does a change of temperature affect this value?

6. State Ohm's law, Joule's law, Faraday's laws of electrolysis and define the following terms: induced current, potential, north magnetic pole, watt and kilowatt.

B.—Answer any Five.

1. Make a diagram of a combination of double pulleys which shall have a mechanical advantage, 5 —. If the force required to overcome friction is 0.25 of the total force exerted, what is the efficiency of the combination?

Make a diagram of a combination of pulleys and inclined plane which shall have an advantage of 20.

169. An eight-oared crew makes 35 strokes per minute. The pull in each stroke is for a distance of 5 feet, and the average pull per man during each stroke is 70 lbs. Calculate the horse power of the crew.

3. A tuning fork is held over a resonance tube and resonance occurs when the surface of the water in the tube is 10 cm. below the fork; it next occurs when the water is 26 cm. below the fork. Taking the velocity of sound to be 345 meters per second at room temperature, calculate the frequency of the fork.

Does the wave-length of sound from a fork of constant frequency vary with rise of temperature? How?

4. When a bicycle tire is pumped up with a foot-pump, why does the bottom of the pump get hotter than the top of it?

The water at Niagara falls 160 feet and is heated 0,°12. If lead fell the same distance, how much would its temperature be raised? Sp. heat of lead = 0.033.

170. Electric energy costs 8 cents per k. w. hour. A 110 volt motor takes 2 amperes. How much will it cost to run the motor for 30 days, 10 hours per day?

If in 50 minutes, an electric current deposits 19.56 gr. of copper, what is the value of the current? Electrochemical equivalent of copper = 0.00326.

6. Two lights are placed at 100 and 20 cm. respectively from a vertical rod standing 8 cm. in front of a white screen. If the intensities of the two shadows on the screen are the same, what is the ratio of the two candle-powers?

Show the lens system of an ordinary astronomical telescope.

171. *Proposed by N. Anning, Clayburn, B. C.*

Find the position of rest of an ordinary steel carpenter's square of uniform thickness when hung on a nail.

Solutions and Answers.

159. *Proposed by Geo. Y. Sosnow, Newark, N. J.*

What would happen if 1000 calories of heat were applied to 80 gm. of ice at 0° C.?

Solution by P. K. Shah, B. A., and C. M. Jhaveri, B. A., Boy's High School, Sojitra, India.

80 calories of heat melt 1 gram of ice.

∴ 1000 calories of heat will melt 12.5 grams of ice.

i. e., After the experiment, we shall have 12.5 grams of water, 67.5 grams of ice, the whole mass at 0° C.

160. *Proposed by H. C. McMillin, Kingman, Kans.*

Compare the times of descent of a hollow and a solid sphere rolling down an inclined plane.

Solution by P. K. Shah and C. M. Jhaveri, Boys' High School, Sojitra, India.

When a ball rolls down an inclined plane, the space is proportional to acceleration and to the square of the time, Hence, as the weight of the ball does not form part of the things on which the time depends, both the solid and the hollow balls will roll down during the same time to the same distance.

156. *Also solved by P. K. Shah and C. M. Jhaveri.*

161. *From a Harvard entrance examination paper.*

A diamond ring weighs 4.00 grams in air and 3.72 grams in water. Find the weight of the diamond if the specific gravity of gold is 17.5 and that of diamond is 3.5.

Solution by Ira Stineman, City High School, Knoxville, Tenn.

Let x = weight of diamond. (1)

$4-x$ = weight of gold in ring. (2)

Then, by Archimedes' Principle:

$$3.5 = \frac{x}{\text{loss of weight of diamond in water}}. \quad (3)$$

$$17.5 = \frac{4-x}{\text{loss of weight of gold in water}}. \quad (4)$$

$$\text{Loss of weight of diamond in water} = \frac{x}{3.5}. \quad (5)$$

$$\text{Loss of weight of gold in water} = \frac{4-x}{17.5}. \quad (6)$$

Adding equations (5) and (6):

$$\text{Loss of weight of diamond}+\text{loss of weight of gold} = \frac{x}{3.5} + \frac{4-x}{17.5}. \quad (7)$$

But loss of wt. of diamond+loss of wt. of gold = .28 grams. (8)

$$.28 = \frac{x}{3.5} + \frac{4-x}{17.5}. \quad (9)$$

Whence x = .225 grams. Answer. (10)

Note by A. Haven Smith, Polytechnic High School, Riverside, Cal.

"It seems to me that this problem is rather difficult to hand out in an entrance examination."

Also solved by Stanley T. Baker, Freeport, N. Y.; Hugh Bersie, Evanston, Ill.; R. T. McGregor, Topaz, Cal.; A. Haven Smith, Kingman, Kan.

162. If a silver spoon weighing 30 grams be put into a cup weighing 80 grams which contains 180 grams of coffee at 80° C., how much will the coffee be cooled?

Specific heat of the coffee = 1.0.
Specific heat of silver = 0.056.
Specific heat of the cup = 0.20.

Initial temperature of the spoon = 15° C.

Solution by Hugh Bersie, Northwestern University, Evanston, Ill.
Data:

Silver spoon weighs 30 grams; tea cup, 80 grams; coffee (80° C.), 180 grams; specific heat of coffee, 1.0; specific heat of silver, 0.056; specific heat of cup, 0.20.

Silver spoon put in cup containing coffee.

Final temperature of coffee = ?

Initial temperature of spoon = 15° C.

Formulas:

(1) Specific heat of substance = heat required to raise 1 gram 1° C.

(2) Heat capacity of a body = heat required to raise its temperature 1° C.

(3) Heat given out by coffee and cup = heat absorbed by spoon.

Substitution:

(2) Heat capacity of coffee and cup = 180+16 = 196 calories.

(2) Heat capacity of spoon = 1:68 calories.

Let T represent the final temperature.

$$196(80-T) = 1.68(T-15).$$
$$15680-196T = 1.68T-25.2.$$
$$197.68T = 15705.2.$$
$$T = 79.438° \text{ C.}$$
$$80-79.438 = .553° \text{ C. Ans.}$$

Also solved by A. Haven Smith and Stanley T. Baker.

Relating to objection to No. 142 published in October issue.

The statement of the problem in calling for "the angle" between the rope and the post implies that friction is not to be considered. Consequently the tension is uniform throughout the rope. Denoting the angle between the rope and the post by a, we have without assuming anything:

$$T \sin a + T \sin a = T.$$
$$\therefore a = 30°.$$

To suppose a knot in the rope which contradicts the statement of the problem and then use the above equation very rightfully leads to an absurdity. H. C. McMillin, *Kingman, Kan.*

LIVE CHEMISTRY.

The following experiments are taken by permission from "A Laboratory Manual of Synthetic Agricultural Chemistry," by Dr. C. A. Peters of the Massachusetts Agricultural College, Amherst, Mass. They afford some very practical work in chemistry for students who expect to specialize in Agriculture. The loose leaves of this manual containing thirteen experiments can be obtained for 25c. Some are perhaps too difficult to use in first year chemistry. They constitute, however, the best experiments in this subject that have come to our notice.

H. R. Smith, *Lake View High School, Chicago.*

Bordeaux Mixture.

This preparation when made on a commercial scale uses 4 lbs. of copper sulfate, with 4 lbs of slaked lime diluted to 50 gals. with water.

The reactions are as follows:

$CaO+H_2O = CaO_2H_2$.
$CuSO_4\ 5H_2O+CaO_2H_2 = CuO_2H_2+CaSO_4+5H_2O$.

Procedure: Weigh out 10 grams of copper sulfate, and dissolve in a small volume of water, using heat if necessary, then dilute to 300 or 400 cc. with cold water.

Calculate the amount of quick lime, CaO, (only one calculation) that will unite with the 10 grams of copper sulfate. If the lime is slaked a larger quantity equivalent to the 10 grams of the oxid must be used. Weigh out about four or five times this amount of lime, slake it in a porcelain dish, hastening the action by heating. Dilute the slaked lime, calcium hydroxid, to 300 or 400 cc. Cover a funnel with a piece of cheese cloth and strain the milk of lime through the cloth to remove lumps. Pour the copper solution into the lime with stirring. The resulting mixture is "Bordeaux," and is ready to be used in spraying.

Notes: Agricultural practice seems to have established the use of four or five times the equivalent quantity of lime. The reason for doing this is not definitely known. The excess caustic lime may act as a fungicide itself, or the presence of this base may prevent the formation of copper carbonates and their partial solution in the carbon dioxid present in the air and given off by the plant. The lime will combine with carbon dioxid more readily than copper hydroxid.

The mixing of warm or hot solutions will produce a hydrated copper oxid with less water than the normal. These compounds are easily recognized by a change in color, being darker than the blue hydroxid. They are, undoubtedly, of equal value as fungicides, but their power of suspension is greatly reduced.

It is extremely desirable that the lime and the copper salt be mixed at such temperatures and dilutions that the resulting product will stay a long time in suspension.

Questions to be answered in notebook:

How much lime was added to the mixture?
How much lime combined with the copper?
How much lime is in solution?*
How much lime is in the sediment?

Name three insoluble substances in the Bordeaux mixture, giving color of each.

What two substances are in solution, and what are the proportionate amounts of each in solution?*

The white scum which forms on the surface of the liquid after the Bordeaux mixture has stood some time is a salt, calcium carbonate; from what two substances has it been made?

What other substances could be put together to make copper hydroxid?

Why do you think the two substances designated are used in ordinary practice?

Tests: Does the liquid left after the mixture settles contain any copper salt in solution? Try the action of a few drops of potassium ferrocyanide upon a dilute copper sulfate solution. Observe the brown copper ferrocyanide. This is a test for copper. Now see if the Bordeaux mixture contains any undecomposed copper sulfate. Note the conclusion.

Add one drop of dilute ammonia to copper sulfate solution. Notice the blue copper hydroxid. Add more ammonia and observe the soluble blue compound. This is also a test for copper.

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*See Blanchard p. 180 for solubility of calcium compounds.

Paris Green.

Dissolve 9 grams of dry carbonate of soda, or 24 grams of the hydrous,

in a beaker or porcelain dish in 80 cc. of water. Into this solution sprinkle in gradually 16 grams of arsenious oxid and boil until the acid has united with the soda as shown by solution of the resulting sodium arsenite.

Dissolve 20 grams of copper sulfate in 80 cc. of water. When both of the solutions are at about 60°—as warm as the hand can comfortably bear—pour the sodium metaarsenite solution into the copper sulfate. Add 10.5 cc. of 50 per cent acetic acid and allow the mixture to digest at about 50° for some time on a piece of asbestos board over a low flame. If the green copper acetoarsenite does not form at this point, not enough acetic acid has been added. Consult an Instructor before adding more than a few drops of acid as too much may decompose the salt. Stir occasionally—once in five minutes—and when the reaction seems complete drain on a funnel and wash to remove soluble arsenites and sodium sulfate. Examine the size and shape of the particles under a microscope. When dry put in a clean, dry beaker and see if it "flows" well.

Notes: Paris green is one of the oldest arsenical insecticides. For many years it was the standard remedy for the potato beetle. It is applied to the vines by sprinkling or spraying a suspension in water.

Paris green is generally considered an acetoarsenite of copper, $Cu(C_2H_3O_2)_2 \cdot 3Cu(AsO_2)_2$. In the solution from which it is made, arsenite, acetate and copper ions must be in such concentrations and the temperatures so adjusted as to best allow the formation of the desired salt. Too much acetic acid will throw the white arsenious acid out of solution. The base and acids concerned are all weak and the compound is quite easily hydrolyzed by water; hence the long digestion to allow the formation of large particles as the ratio of mass to surface, m : s, is greater in a large particle than in a small one.

The amounts must be weighed with considerable care as the effect of varying masses of reagents is easily noticeable.

Questions:

Name the acidic and basic ions in Paris green.

What shaped particle has the largest ratio of m :s?

What are the relative advantages of Paris greens composed of large particles; of small particles; of particles of spherical shape; of broken cornered particles? Discuss in reference to degree of hydrolysis and time of suspension.

What is the objection to putting Paris green in water several days before using? Of applying on a wet day?

This experiment is based on the work of Holland and Reed (Mass. Exp. Station, 1912).

A COMBINED DENSITY BOTTLE AND DILATOMETER.

By E. T. Bucknell,

Kingsholme School, Weston-super-Mare, England.

This little apparatus will be found very useful in a physical or chemical laboratory, as by means of it several typical experiments, both in density work and dilation of liquids under the influence of heat, can be carried out.

The bottle, Figure 1, is calibrated so as to hold 50 c. c. when filled to the lowest division, B, of the neck, which is graduated. The mouth of the bottle, A, is ground, and fitted with a ground-glass stopper, which prevents evaporation of the contents when not in use. Thus with half a dozen such bottles, it is easy to keep each filled with a different liquid, and hence find the co-efficient of cubical expansion of each liquid quickly.

No washing and drying the bottle would be required, and such operations often take up a great deal of valuable time in a laboratory.

The following results of experiments show some of the work which can be accomplished with the bottle:

To Find the Average Volume of a Lead Shot.

The bottle was previously counterpoised. In filling the bottle with a liquid, it is better to use a thistle funnel, in order to avoid wetting the upper portions of the neck.

Level of water after adding 40 lead shot = 50.45 c. c.
Level of water before adding lead shot = 50.00 c. c.

∴ Volume of 40 lead shot = 0.45 c. c.
Average volume of one shot = 0.45÷40 = 0.01125 c. c.

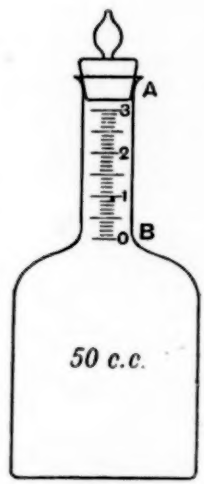


Fig. 1

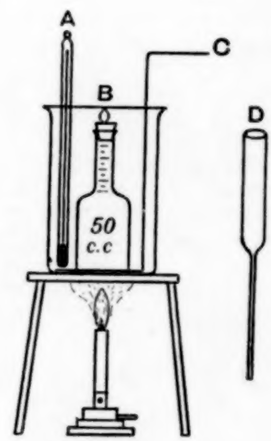


Fig. 2

To Find the Density of Lead Shot.

Weight of bottle of water+40 lead shot = 55.185 grams.
Weight of bottle of water filled to zero mark = 49.976 grams.

∴ Weight of 40 lead shot = 5,209 grams
Density = 5.209÷0.45 = 11.57.
Level of water after adding 40 lead shot = 50.45 c. c.
Level of water before adding lead shot = 50.00 c. c.

∴ Volume of lead shot = 0.45 c. c.

The densities of substances soluble in water, e. g., sugar, copper sulphate, etc., can be obtained by substituting alcohol, turpentine, etc., for water, in the bottle.

To Find the Specific Gravity of Methylated Spirits.

Weight of bottle of water filled to zero mark = 49.976 grams.
Weight of bottle of methylated spirits filled to zero mark = 41.101 grams.
Specific gravity = 41.101÷49.976 = 0.822.

To Plot a Curve, Showing the Relation Between the Volume and Temperature of a Known Volume of Methylated Spirits Taken at a Known Temperature.

Fit up the apparatus as shown in Figure 2. A is a thermometer, B the flask with a piece of cotton wool in the neck instead of the stopper, to prevent evaporation during the experiment, and C a stirrer. Adjust the volume of methylated spirits in the bottle by means of the drawn-out glass tube, D, until the reading of the liquid is zero. Take the temperature of the water. Now heat gently, stirring well all the time, until there is a rise in temperature of about 5° C. When this rise has taken place, do not read off the increase in volume immediately, but wait for a minute or two, to make sure that the heat from the water bath has penetrated completely through the methylated spirits. Continue the heating, taking readings of temperature and volume for each 5°, until a temperature of about 60° C. has been reached.

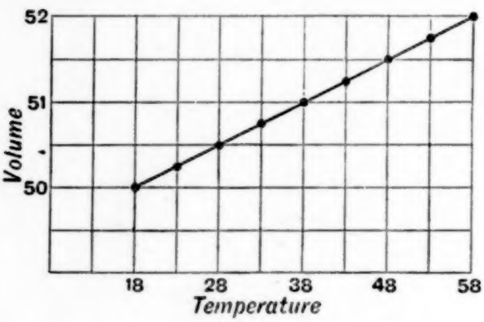


Fig. 3

Volume c. c.	Temp. ° C.	Volume c. c.	Temp ° C.
50.00	18	51.25	43
50.25	23	51.80	48
50.50	28	51.80	53
50.75	33	52.05	58
51.00	38		

Taking as abscissæ the readings of temperature, and ordinates the readings of volume, a curve (Figure 3) can be plotted on millimetre squared paper, which will show clearly within the limits of experimental errors that methylated spirits expands regularly.

To Determine the Coefficient of Absolute Expansion of Methylated Spirits.

This experiment is carried out with the same apparatus as that required for obtaining the data for plotting the curve, the only difference being that it is only necessary to take the volume of methylated spirits and the temperature at the commencement and the end of the experiment; intermediate readings are, of course, unnecessary. Obviously, the coefficient can be calculated directly from the results of the curve-plotting experiment.

Volume of methylated spirits at 53° C. = 51.80 c. c.
Volume of methylated spirits at 18° C. = 50.00 c. c.

Amount of expansion for a rise of 35° C. = 1.80 c. c.

50 c. c. of methylated spirits expand 1.80 c. c. when heated through 35° C.
1 c. c. of methylated spirits expands $1.80 \div 50 \times 35$ c. c. when heated through 1° C.

$$= 0.001028.$$

This is, of course, the coefficient of apparent expansion. By adding to this result the coefficient of cubical expansion of glass (0.000009×3), we get 0.001055 as the coefficient of absolute expansion of methylated spirits. The coefficients of absolute expansion of other liquids may be obtained by this method, the most suitable being benzene (0.00138), petroleum (0.00099), and turpentine (0.00105).

To Determine the Coefficient of Absolute Expansion of Methylated Spirits, Using the Bottle as a Weight Thermometer.

Counterpoise the bottle when clean and dry. Fill with methylated spirits to the zero mark. Weigh so as to obtain the weight of methylated spirits. Heat contents, as shown in Figure 2, taking the temperature at the start and finish of the experiment. Remove the expanded methylated spirits by means of the small pipette shown in D (Figure 2), and allow it to run into a weighed crucible. The volume of methylated spirits remaining in the bottle at the higher temperature must be exactly 50 c. c. Weigh the excess, and calculate the coefficient from the weights and temperatures obtained; or, the methylated spirits remaining in the bottle may be weighed, thus avoiding the use of the weighed crucible.

I have no doubt that other practical exercises in connection with the bottle will occur to science masters, but the typical experiments which I have set out here are sufficient, I think, to show the general utility of the little instrument.—*School World.*

ARTICLES IN CURRENT PERIODICALS.

American Journal of Botany for October; *Brooklyn Botanic Garden, Brooklyn, N. Y.; $4.00 per year; 50 cents a copy:* "Studies of the Development of the Piperaceae. II. The Structure and Seed-Development of Peperomia Hispidula," Duncan S. Johnson; "On the Correlation between Somatic Characters and Fertility. II. Illustrations from Phaseolus Vulgaris," J. Arthur Harris; "The Effects of Acid and Alkaline Solutions Upon the Water Relation and the Metabolism of Plants," Alfred Dachnowski.

American Mathematical Monthly for November; *5548 Kenwood Ave., Chicago; $2.00 per year:* "An Equation Balance for Class-Room Use," E. W. Ponzer; "Groups of Figures of Elementary Geometry," G. A. Miller; "On a Special Case of the Tetrahedral Complex," D. N. Lehmer; "On the Use of Partial Derivatives in Plotting Equations from their Curves," A. M. Kenyon; "A Method of Solving Numerical Equations," S. A. Corey; "A Formula for the Sum of a Certain Type of Infinite Power Series," E. H. Clarke.

American Naturalist for November; *Garrison, N. Y.; $4.00 per year, 40 cents a copy:* "A Comparison of the Responses of Sessile and Motile Plants and Animals," Victor E. Shelford; "An Apterous Drosophila and Its Genetic Behavior," Charles W. Metz.

Educational Psychology for November; *Warwick and York, Baltimore, Md.; $1.50 per year; 20 cents a copy:* "Educational Research in New Orleans," David Spence Hill; "A Modified Slide Rule and the Index Method in Individual Measurements," A. P. Weiss; "A Comparison of the Ayres and Thorndike Handwriting Scales," Rudolf Pintner.

Journal of Geography for November; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "Geography and the War in Europe," G. B. Roorbach; "The German Campaign in France and Belgium," Lawrence Martin; "Siberia," Leonard O. Packard; "Construction Material of Cities," Frederick Homburg.

Mathematical Gazette for October; *G. Bell & Sons, Portugal Street, Kingsway, London, six nos. 9s. per year, 2s. 6d. per copy:* "The Dissection of Rectilineal Figures," W. H. Macaulay; "Linear Dynamics," Sir George Greenhill; "Note on Desargues' Theorem," D. M. Y. Sommerville; "A Plea for Astronomy," The Astronomer Royal; "Theory of Centroids," Prof. D. K. Picken.

National Geographic Magazine for October; *Washington, D. C.; $2.50 per year, 25 cents a copy:* "Hungary: A Land of Shepherd Kings" (92 illustrations), C. Townley-Fullam; "England: The Oldest Nation of Europe" (11 illustrations), Roland G. Usher.

Nature-Study Review for November; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Seed Collections," Anna B. Comstock; "Preparation of Teachers for Nature-Study and Civic Biology," C. F. Hodge; "The Story of a Kernel of Corn," A. W. Nolan; "An Evening With the Aquarium and Snailery," Frank C. Baker; "An Aquarium in a Tumbler," Elliot R. Downing.

Popular Astronomy for December; *Northfield, Minnesota; $3.50 per year, 35 cents a copy:* "Delevan's Comet 1913 *f*, Photograph," E. E. Barnard, plate xxviii, Frontispiece; "Encke's Comet, on the Possibility of Photographing the Comet at all Points in Its Orbit" (with plate xxix), E. E. Barnard; "Probable Error of Observations of Faint Stars With the Meridian Circle," R. H. Tucker; "Report on Mars No. 7" (with plates xxx, xxxi and xxxii), William H. Pickering; "A Method of Constructing a Vernier for a Small Equatorial," Gilbert Lanham; "American Astronomical Society, Report of the Seventeenth Meeting" (continued); "How to Find the Constellations" (continued).

Physical Review for November; *Ithaca, N. Y.; $6.00 per year, 50 cents a copy:* "On the Absorption of Hydrogen by Sodium Potassium Electrodes," R. C. Gowdy; "The Relation Between Alpha-Ray Activities and Ranges in the Actinium Series With Notes on the Period and Range of Radioactinium," Herbert N. McCoy and Edwin D. Leman; "Determination of the Value of '*e*,' by Millikan's Method, Using Solid Spheres," John Yiubong Lee; "Diurnal and Annual Variations in Overland Radiotransmission," A. H. Taylor; "A Determination of Avogadro's Constant N from Measurements of the Brownian Movements of Small Oil Drops Suspended in Air," Harvey Fletcher; "Color Analyses of Two Component Mixtures," L. A. Jones; "The Influence of Annealing on the Characteristics of Light Sensitive Selenium," E. O. Dieterich.

Popular Science Monthly for November; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "Tree Distribution in Central California," W. A. Cannon; "Phenomena of Inheritance," Edwin Grant Conklin; "Rubber: Wild, Plantation and Synthetic," John Waddell; "Recent Mathematical Activities," G. A. Miller; "The Ultra-scientific School," B. Horowitz; "Arabian and Medieval Surgery," John Foote; "Civilization as a Selective Agency," Roland Hugins; "Ephemeral Labor Movements," Frank T. Carlton; "The Science of Education," John Perry.

Psychological Clinic for November; *Woodland Ave. and 36th St., Philadelphia; $1.50 per year, 20 cents a copy:* "A Study of Defective Pupils in the Public Schools of Tacoma, Wash.,' Robert A. Cummings; "The Hygiene of Eugenic Generation," J. E. Wallace Wallin.

School World for November; *Macmillan and Company, London, Eng.; 7 s. 6 d. per year, 6 pence a copy:* "Commercial Education for Girls," Sara A. Burstall; "School Girls' Work in War-time"; Notes on the Teaching of Congruence," J. V. H. Coates; "Insular Britain: The Effect of the War" (with map), B. C. Wallis; "School Discipline in America," W. H. Winch; Why did We Go To War?" Joseph A. Pease.

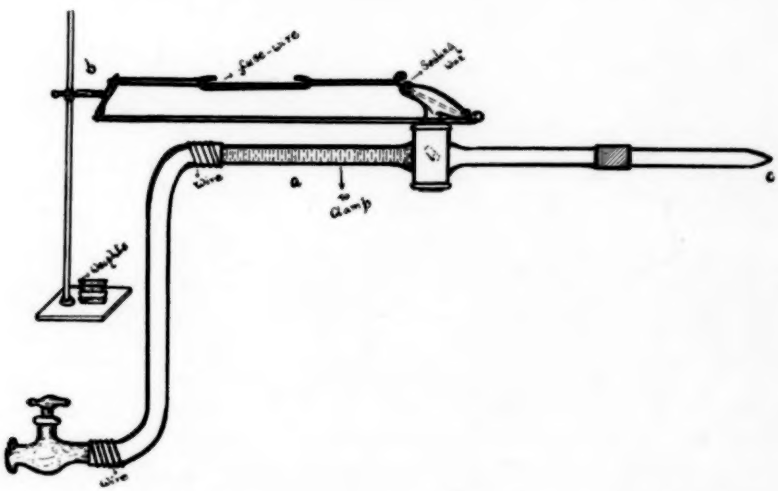
Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for October; *B. G. Teubner, Leipzig, Germany; 12 numbers, M. 12.-per year:* "Die Interferenzerscheinungen der Röntgenstrahlen; der bindende Beweis ihrer Wellennatur und zugleich ein Erfolg der Atomistik" (21 pages), Prof. Wilhelm Hillers; "Angewandte Mathematik und Schule," Dr. P. Zühlke; "Der mathematisch-physikalische Ferienkursus an der Universität Göttingen Ostern 1914 (H. Weinreich).

A SIMPLE DEMONSTRATING FIRE-SPRINKLER.

By Theodore Cohen,
Commercial High School, Brooklyn.

In order to demonstrate the principle of the commercial fire-sprinkler and not having one at hand, it became necessary to construct some simple mechanism that would serve the same purpose. The apparatus shown by the diagram is the result.

A rubber hose attached to a water-faucet is fitted to one arm of a glass stop-cock while to the other arm is fastened by means of a rubber connector a piece of glass tubing drawn out to a point. The points of attachment of the rubber hose are made secure by pieces of wire.



The arm (a) of the stop-cock is held firmly in position by a clamp attached to a ring stand, the base of which is weighted. The ends of the head of the stop-cock are filed off and a piece of wire inserted. The projecting ends are then hooked. Sealing-wax is then applied to the filed ends of the head of the stop-cock to hold the wire firmly. To one of these hooks is attached a rubber band and to the other the combination, a piece of fusible metal (fuse-wire is excellent) and two shorter rubber bands, as shown. The bands are now made taut to another clamp (b) on a ring stand, the base of which is also weighted. The valve of the stop-cock should now be closed. Water under sufficient pressure is sent through the rubber hose to the valve of the stop-cock (when admitting water for the first time open valve slightly and

close when water has reached the valve of the stop-cock). A crystal of $KMnO_4$ (potassium permanganate) dropped into the water in arm (b) shows up very nicely.

The flame of a match head is then applied to the fusible metal which snaps, releases the stop-cock, and allows a forceful jet of water to issue from (c) for a distance of several yards.

The following points are clearly demonstrated:

1. That the water is held in check by a valve, and that,

2. This valve which regulates the supply of water is held in check by a fusible metal which melts at a low temperature.

The writer has not seen any similar piece of apparatus.

STUDY OF SUPPLY AND EXPLOITATION OF TIMBER IN THE UNITED STATES.

The Secretary of Commerce and the Secretary of Agriculture have completed plans whereby their two departments will combine in a constructive study of the supply and exploitation of timber in the United States, which has now become one of the big conservation and industrial problems. The study is to be undertaken in the be'ief that the methods used in exploiting timber resources and the restoration of normal and healthy conditions in the industries which convert timber into usable products, vitally concern the public at large.

One of the conditions which, in the opinion of the Secretaries, makes this study of immediate importance, is the fact that the United States, which contains some 3,000 billion feet of standing timber, is now reducing its stock of stumpage at the rate of sixty or more billion feet annually. In spite of this limited timber supply, lumbermen are now unable to market much of the poorer grades. They therefore leave in the woods or burn in their mi'ls from one-third to one-half of the material in the trees. Poor varieties of timber often are not cut at all, but are left to be burned in the slash fires which usually follow logging. Some of this waste it is believed is preventab'e, and much more, it is hoped, can be saved under improved conditions of marketing and use of wood.

One of the objects of these studies is to lessen this total waste which, if allowed to continue, will be felt sooner or later. Because of these and other existing conditions in the timber and lumbering districts, the Secretaries of both departments fee' that there is need to devise betterments in the interest alike of the forest-using industries and the consuming public.

The more important elements in the project of the two departments are as follows:

The studies will seek to establish the essential facts relating to supp'y, exploitation and marketing of timber at home and abroad, and to analyze the underlying causes of present unsatisfactory conditions. The aim will be to deal he'pfully with the various problems presented, and to indicate as far as it may be practicable, measures which should be adopted by the industry itself, or by the public in relation to the industry. The studies will be conducted directly by the Forest Service in the Department of Agricu'ture and the Bureau of Foreign and Domestic Commerce, with the coöperation of the Bureau of Corporations and the Bureau of Standards of the Department of Commerce, within their special fields.

All the information hitherto gathered by these different agencies as to the standing timber, the manufacturer and marketing of lumber, the quality of various timbers, and the more economical and more profitable utilization of wood will be correlated with any new data gathered and used to indicate improvements.

Among the related industrial and business questions which will be considered are the effects upon lumber production of speculation in standing timber and the carrying charges on private stumpage; the extension of markets including the development of the foreign market for lumber and other forest products and the marketing of material in new forms; and the competition of lumber produced in other countries and of other materials used for the same purposes.

Attention also will be given, in the interests of consumers and manufacturers, to the questions of the distance between the producer and the consumer, and the distributing agencies which absorb a considerable part of the retail price.

The inquiry has to do not only with the thrifty use of the present timber supply, but also with the possibility of applying forestry in the future management of private timber lands.

TRANSMISSION OF BUBONIC PLAGUE BY FLEAS.

The importance of the flea in the transmission of bubonic plague is now generally recognized. The Commission for the Investigation of the Plague in India indicated as the result of its work during 1906 and 1907 that transmission of plague from one animal to another could readily be brought about by fleas; and that only in the presence of fleas did an epizoötic among rats or guinea pigs ensue. Close contact with infected animals, including the devouring of infected carcasses, was occasionally followed by a case of plague, but no spread of the disease occurred. Animals allowed to remain in animal-houses in which plague had occurred and in plague-infected native quarters became infected; but no infection resulted, according to *The Journal of the American Medical Association*, if the simplest measures were taken to prevent the access of fleas.

PANORAMIC VIEW OF YOSEMITE NATIONAL PARK.

A panoramic view of Yosemite National Park, showing the characteristic features of the landscape, has just been issued by direction of Secretary Lane. This panorama shows in a striking manner the gradual rise in the elevation of the country from the western boundary of the park to the eastern boundary along the crest of the Sierra Nevada, and the sudden drop to the level area of the Great Basin. Eight colors were used in the printing, the meadows and valleys being in light green, the streams and lakes in light blue, the cliffs and ridges in combinations of colors in order to give the hazy effect characteristic of the region, and the roads in light brown. The lettering is printed in light brown, which is easily read on close inspection, but which merges into the basic colors when the sheet is held at some distance. The panorama is surrounded by a gray border in order to make an effective background. This view, which may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 25 cents, measures 18½ by 18 inches, and is on the scale of three miles to the inch. It is based on accurate surveys and gives an excellent idea of the configuration of the surface as it would appear to a person moving over it in an aeroplane.

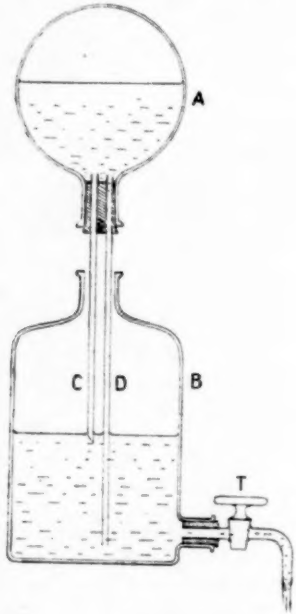
A MODEL FOR USE IN TEACHING LATENT HEAT.

By Thomas W. Page,
Municipal Secondary School, Cardiff, England.

I am sending you a diagram of a mechanical model which I have found useful in explaining the cooling curve of paraffin wax and the subject of latent heat, which I think may prove of interest to your readers.

The apparatus is shown for simplicity without the necessary supports.

The bottle, B, is filled with water; and the flask, A, filled with water and fitted with two tubes, C and D, is inverted as shown, the tube, D, reaching to the bottom of the bottle; and the tube, C, the end of which is cut obliquely, reaching about half-way down. On turning the tap, T, the level of the water in B descends at a rate depending upon its height above the outlet. When the level reaches the lower end of C it remains constant while the water in A flows through the tube D into B, air entering the



tube, C, and rising into A. This continues until A is empty, and during this time the level in B and the rate of outflow at T are constant. The level of the water in B then falls, and the rate of outflow gradually decreases. The water in A represents the latent heat of fusion of the wax, and the level of the water in B represents the temperature of the wax. The level of the lower end of C represents the melting point and the level of T the temperature of the surroundings. The experiment illustrates the facts that the temperature remains constant until the whole of the latent heat has been given out, and that during this time heat is being radiated at constant rate; that the temperature of the melting point is independent of the rate of loss of heat, and also the fact that the rate of loss of heat decreases as the temperature of the wax approaches that of its surroundings.—*School World.*

ANNUAL MEETING, CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, CHICAGO, ILL., NOVEMBER 27 AND 28, 1914.

General Minutes.

The fourteenth annual meeting of the Central Association of Science and Mathematics Teachers was convened, November 27, 1914, in the Auditorium of the Hyde Park High School. The Association was hospitably welcomed by Ella Flagg Young, Superintendent of Schools of Chicago. Miss Marie Gugle replied on behalf of the Association. The new sections of Agriculture and Home Economics were welcomed in an address by Dean O. W. Caldwell to which an appropriate response was made by Miss Abby Marlatt, Head of the Department of Home Economics in the University of Wisconsin.

The principal addresses of the session were by Dean Eugene Davenport, of the University of Illinois, and Miss Martha Van Rensselaer, Head of the Department of Home Economics in Cornell University. In the absence of Dean Davenport his address was read by Professor A. W. Nolan, of the University of Illinois. These addresses will appear in the Proceedings of the Association.

The Committee on a Four-Year High School Science Course made a progress report through its chairman, Dean Caldwell. The report was adopted and the committee continued.

The report of the Committee on Resolutions was presented by its chairman, Mr. James H. Smith, and the resolutions were adopted. They are printed elsewhere in the Proceedings.

The afternoon was occupied with section meetings and an informal reception in the foyer of the building.

After the annual dinner in the evening the members adjourned to the Physics Lecture Room and listened with great interest to an address by Charles Hughes Johnston of the University of Illinois.

During the morning session, during the reception, and after the dinner the Association was favored with musical numbers which were rendered by several organizations and individuals. The appreciation of the Association is expressed in resolutions which are entered in these minutes.

At the General Session on November 28th, the Treasurer read the membership report and the financial report for the year. Both of these, together with the report of the auditing committee, are appended to the minutes. These reports were accepted and approved.

The following bills were allowed and ordered paid:

Expenses of C. H. Johnston	$14.50
Expenses of Martha Van Rensselaer	
Physics Section, expenses	12.90
Earth Science Section, postage	8.00
Secretary's office	.92

A vote of thanks to those most largely responsible for the perfection of the local arrangements was unanimously voted in the following terms:

"The success of the 1914 meeting of the Central Association of Science and Mathematics Teachers has been due in large part to the efficient organization and management of the teachers of the Hyde Park High School, and to Mr. C. H. Smith, chairman of the local committee. Not only have they cared for all the usual needs of the association meeting but they have also provided a complimentary luncheon for Saturday noon.

"The musical organizations of the school and the Chicago Teachers Chorus, their instructor, Mr. O. E. Robinson, and Miss Eda D. Ohrenstein,

who favored us with vocal selections at the dinner Friday evening, have added greatly to the enjoyment of the meeting.

"The Association wishes to express its keen appreciation of these measures for the success and enjoyment of the meeting by extending formally a vote of thanks to all those mentioned above."

On motion, decided that the president-elect shall appoint a committee on necrology, consisting of three members.

It was ordered that the president-elect appoint a committee to propose necessary changes in the constitution, particularly such as are demanded by the admission of two new sections.

Invitations for the next meeting were extended by a number of educational officers and organizations of Columbus, Ohio, and by the Harrison Technical High School of Chicago. The selection of the location of the next meeting was referred to the Executive Committee, but it was also decided that the next meeting to be held away from Chicago shall be held at Columbus, Ohio.

The committee on nominations reported as follows:

For President, C. E. Spicer, Township High School, Joliet, Ill.
For Vice President, Jessie F. Caplin, West High School, Minneapolis.
For Secretary, A. W. Cavanaugh, Lewis Institute, Chicago.
For Assistant Secretary, M. Faith McAuley, High School, St. Charles, Illinois.
For Assistant Treasurer, H. H. Radcliffe, High School, Connersville, Indiana.

The secretary was ordered to cast the ballot of the meeting for these nominees and all were duly elected.

Meeting adjourned. W. L. Eikenberry, *Secretary*.

Treasurer's Report for Year Ending November 26, 1914.

Paid up Membership, November 28, 1913		619
Honorary Membership, November 28, 1913		7
Total Membership, November 28, 1913		626
Delinquent, but left on list in accordance with Constitution		62
Total names on list November 28, 1913		688
New names added during the year		177
		865
Resigned during year	53	
Deceased or dropped for delinquency	34	87
Total names on list November 26, 1914		778
Delinquent, but left on list as per Constitution	89	
Honorary membership, November 26, 1914	9	98
Paid up membership, November 26, 1914		680
Net membership increase for year		61

Treasurer's Report for Year Ending November 26, 1914.

Receipts.

Balance at previous report	\$ 395.17
Advertisements in 1913 program	165.00
Tickets sold for annual dinner	1.20
Copy of correlation report	.25
Twenty copies of Proceedings sold at 50 cents each	10.00
Dues of 535 members at \$2.50	1,337.50

Dues of 26 members at 2.00	52.00
Dues of 7 members at 1.50	10.50
Dues of 35 members at 1.00	35.00
Dues of 33 members at .50	16.50
Dues of 1 member at	1.67
Total Receipts	$2,024.79

EXPENDITURES.

Subscriptions to SCHOOL SCIENCE AND MATHEMATICS	$ 850.67
Proceedings 1913, printing and distributing	232.59
Rebates to local centers	32.50
Postage in treasurer's office	38.50
Program 1913, printing and distributing	272.16
Speakers 1913 meeting	108.15
Badges 1914	11.09
Membership committee expense	36.07
General printing, receipts, reprints, etc.	68.75
President's expense, miscellaneous	7.93
Treasurer's expense, miscellaneous	5.90
Secretary's expense, miscellaneous	7.06
Four-year science course committee	14.45
Chemistry section, postage committee	5.00
Physics section, postage	1.50
Biology section, postage	5.00
Earth Science section, postage	1.25
Publicity committee expense	.60
Executive committee expense	2.00
	$1,701.17
Balance, cash on hand	$ 323.62

Minutes of the Earth Science Section.

The meetings of the Earth Science section of the C. A. S. and M. T., held under the chairmanship of Prof. G. F. Kay, of the University of Iowa, proved very interesting. In keeping with the spirit of the whole Association, that was considering "Problems in Adjusting Applied Sciences to High School Curricula," the various phases of geography presented were mathematical, botanical and political.

The first paper on "Interesting Paradoxes in Mathematical Geography" was prepared by Mr. W. E. Johnson, President of the State Normal and Industrial School, of Ellendale, N. D. Because he was unable to be present, the paper was read by the secretary.

"Practical Aspects of Plant Geography" were presented by Dr. Henry C. Cowles, Professor of Botany in University of Chicago. In his characteristic and interesting way, he told how the origin of some cultivated plants had been traced, and that most of our crops of first rank had originated in Asia Minor, the India-Malay tropical region, and in tropical America. In considering the very important relation of cultivated plants to soil, he referred to Dr. H. L. Shantz's work on the dry plains of eastern Colorado, where he has been investigating alkali and drought resistant plants. Some of his results are given in Bulletin No. 201, of the Bureau of Plant Industry. It is entitled "Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area." His main idea is to see what grows naturally on the soil, and let that guide one in introducing cultivated plants. Dr. Cowles also referred to the value of knowing the evolution of natural vegetation. In a lawsuit over

timberland in Arkansas, that had been wrongly surveyed, and mapped as lake regions, the case was settled by the presence of living upland trees, as oaks, that Dr. Cowles found growing in the center of the so-called lake area. The fact they were there, showed that no lake could have existed there less than 2,000 years ago.

Miss Ruth Williston, of Oak Park High School, told of her experience in presenting Plant Geography in a Botany course.

"The Purpose of Political Geography" was given by Prof. W. S. Tower of the Department of Geography, University of Chicago. He said that political geography is not analytical for its main purpose is not to take apart and reveal the character of all the component elements in a country. It is rather synthetic. Its main object is to show how the various elements in a country work together in the life of the nation, which occupies that country. This involves an explanation of how geographic conditions have influenced (1) the creation of nations as they now are; (2) the relation of nations to each other; and (3) what the different nations stand for to-day. Political geography is really the geographic interpretation of peoples. The discussion was led by Miss Mabel Stark of Normal, Ill.

The work of two committees was reported. Mr. Peet of Lewis Institute explained the "Present Status of High School Physiography." Mr. James H. Smith of Austin High School, and Mr. Harry B. Clem of Marshall High School, both of Chicago, showed pictures that might be used as illustrative material for physiography. The motion was carried to continue the committees another year, and the committee on illustrative material was to find out if textbook companies would furnish enlarged pictures of those shown in their textbooks, to be used as a part of the teacher's equipment.

The officers elected for the following year were: Chairman, Mr. C. S. Winslow of Senn High School, Chicago; Vice-Chairman, Miss Marion Sykes of Bowen High School, Chicago; Secretary, Miss A. E. Aitchison, of Cedar Falls, Iowa. GRACE J. BAIRD, *Secretary.*

BOOKS RECEIVED.

Principles of Cooking, by Emma Conley, Inspector of Domestic Science for Wisconsin. 206 pages. 12.5x19 cm. Cloth. 1914. American Book Company, Chicago.

Solid Geometry, by Sophia Foster Richardson, Vassar College. Pages v+209. 13.5x19 cm. Cloth. 1914. 90 cents. Ginn and Company, Boston.

Nutrition and Diet, by Emma Conley. 208 pages. 13x19 cm. Cloth. 1914. American Book Company, Chicago.

Household Science and Arts, Boston Public Schools. 256 pages. 13x19 cm. Cloth. 1914. American Book Company, Chicago.

Engineering Workshop Drawing, by Henry J. Spooner, Polytechnic School of Engineering, London. 128 pages. 23.5x17 cm. Paper. 1914. (S) 50 cents. Longmans, Green and Co., New York City.

Qualitative Chemical Analysis, by Chalfant E. Bivins, Pratt Institute, Brooklyn. 190 pages. 20.5x27 cm. Paper. (Wd) 1914. $1.00 net. John Wiley and Sons, New York City.

Pedagogy of Arithmetic, by Henry Budd Howell, Public School No. 27, Jersey City. Pages xi+328. 14x20 cm. Cloth. 1914. (C) $1.25. The Macmillan Company, New York City.

The Grm-Cell Cycle in Animals, by Robert W. Hegner, University of Michigan. Pages x+346. 13.5x19.5 cm. Cloth. 1914. (W) $1.75. The Macmillan Company, New York City.

Principles and Methods in Commercial Education, by Joseph Kahn and

Joseph J. Klein, College of the City of New York. Pages xiv+439. Cloth. 1914. (A) $1.40 net. The Macmillan Company, New York City.

An Introduction to the Study of Fossils, Plants and Animals, by Hervey W. Shimer, Massachusetts Institute of Technology. Pages xiv+450. 14x19.5 cm. Cloth. 1914. (W) $2.40 net. The Macmillan Company, New York City.

BOOK REVIEWS.

A Laboratory Outline of General Chemistry, by Alexander Smith, Professor of Chemistry and Head of the Department of Chemistry of Columbia University, N. Y. Pages 137. 1914. The Century Co.

This is an excellent manual of general inorganic chemistry for high schools. It is arranged to go with the author's text, *A Textbook of Elementary Chemistry.* One very strong feature of the manual consists in the stating of the purpose of the experiment at the outset so that the pupil may know what he is "driving at."

There are 87 exercises in the manual, more of course than any pupil could perform in the time usually allotted to the chemistry course but giving the teacher a chance to select according to the needs of his class.

The instructions as to the handling of oneself in the laboratory are given as required, not all at once. This is a commendable feature of the book. The preliminary instructions such as those in connection with glass-working are very good. There is much instruction blended with the directions, as needed. This is a most effective way to handle such instruction and to correlate the laboratory work and the principles which are being taught. The wording of the instructions is concise, yet clear. An excellent laboratory manual. F. B. W.

The Birds of Connecticut—State of Connecticut State Geological and Natural History Survey, Bulletin No. 20 by John Hal Sage, M. S., Secretary of the American Ornithologists Union, and Louis Bennett Bishop, M. D., Fellow of the American Ornithologists' Union, Assisted by Walter Parks Bliss, M. A.

The state of Connecticut through the Natural History Survey is issuing a series of valuable bulletins of natural history. *The Guide to Insects,* Bulletin 16, has been heretofore noticed in these columns. The volume before us is a book of 370 pages by competent students of birds. It should be a valuable reference work for any bird student. It has special value to teachers of zoölogy from its section on Economic Ornithology by Mr. Bishop. Some 110 pages are devoted to this subject with much useful information. W. W.

First Book of Zoölogy, by T. H. Burlend, M. A., B. Sc., Lecturer in Histology and Embryology in the University College of South Wales and Monmouthshire. Small 12 mo. Pages 159+vi. Figures 105 with 4 colored plates. 1913. 50 cents net. The Macmillan Company.

This is a good book and worthy of consideration in schools where the time that can be given to zoölogy is limited and the laboratory facilities meager. Beginning with the earthworm it takes up a series of common animals ending with mammals. The language and style are simple and direct and the illustrations good. New and important words in the text are printed in bold-face type, making it easy for the pupil to review and retain the points covered by these words. The treatment of each animal is thorough and painstaking within the limits set for the work. Suggestive laboratory directions are added with each chapter. W. W.

How Man Conquered Nature, by Minnie J. Reynolds. Small 12 mo. Pages 249. Illustrated. 1914. 40 cents net. The Macmillan Company.

This book is one of the "Every Child's Series" by the Macmillans. It presents the story of man's conquest in simple language for children. The typography of the book is good and the story seems to be well written. W. W.

Water Reptiles of the Past and Present, by Samuel Wendell Williston, Professor of Paleontology in the University of Chicago. Large 8 vo. vii+251 pages, with 231 cuts and figures. 1914. The University of Chicago Press.

Secondary school teachers of zoölogy who are not specialists will be interested in this book. It is not too scientific, thus destroying the interest for the non-specialist, yet it is sufficiently scientific for accuracy of statement. It gives a view, which is difficult to get elsewhere, of the evolution and the interrelation of the various orders of vertebrates—especially of those which have adapted themselves to water life. Much attention is given to their adaptation to environment and much light is thrown upon changes of structure brought about by changes of environment, such as a change from land to water life.

A good many restorations are shown which are very helpful in gaining a clear conception of the animals of the past. The reviewer can heartily recommend this book as worthy of a place in the libraries of all zoölogy teachers and of others interested in life in general and its evolution. W. W.

Introduction to Organic Chemistry, by John Tappan Stoddard, Professor of Chemistry in Smith College. Pages ix+419. 13x18x2¼ cm. 1914. Price $1.50 net. P. Blakiston's Son & Co., Philadelphia.

This little book impresses one as a very teachable course in organic chemistry. The introduction takes up in an admirable manner the reasons for studying organic chemistry separately from inorganic chemistry and the essential unity of the two branches is clearly pointed out. The order of treatment of topics in the book is an excellent one although the author modestly disclaims any special merit for it and states in his preface that the sequence may readily be re-arranged by anyone who chooses to teach the subject in some other order. The paraffins are first treated, each type of derivative being assigned as a rule, a separate chapter, which gives the student a better chance to learn the new work by segregating it in small readily grasped increments.

The study of the aromatic hydrocarbons is reserved for Part II of the book and the subject is led up to through a brief chapter (the final chapter of Part I) on the Cyclo-paraffins.

The author has carefully selected a few only of the most important compounds of each type for consideration and by this intensive method has made it possible for the student to grasp the general principles of the subject. This method of treatment is of great value both to the student who pursues chemistry further and to the student who takes chemistry as a part of a liberal education.

The practical applications of many of the substances studied are touched upon which makes the book more interesting and takes off from it much of the dryness of the purely theoretical type of book.

While intended as a text to accompany the lectures in a first course in organic chemistry in colleges the book would also be useful as a reference text for pupils to use in high school courses in chemistry.

F. B. W.

Guide to the Study of Animal Ecology, by Charles C. Adams, Ph. D., Associate in Animal Ecology, Department of Zoölogy, University of Illinois. 12 mo. Pages xii+183 with seven full page figures. 1913. The Macmillan Company, New York.

As the title indicates, this book is a guide to the student rather than a treatise. Its mission is to advise, point out the way and refer to literature on the various topics. The numerous well-chosen reference lists of authors and books must prove very helpful.

Some of the chapter and section headings will help to give a good idea of the scope of the book: "Field Study"; "Collection, Determination and Preservation of Specimens"; "References to Important Sources of Information on the Life Histories and Habits of Insects and Allied Invertebrates"; "The Relation of Animals to Pollination and to Plant Galls," etc.

The study of the ecology of animals is peculiarly adapted to the possibilities of the average high school teacher of zoölogy in the way of research work. The teacher in the high school is tempted to fall into a fixed routine. The field of ecology offers any number of fresh problems for study—for a hobby, something every teacher should have outside his routine. Professor Adams' book affords a way to find the particular problem needed. W. W.

Laboratory Studies in Mammalian Anatomy, by Inez Whipple Wilder, A. M., Assistant Professor of Zoölogy, Smith College. Pages xi+156. 8 vo. Cloth. 1914. Price, $1.25 net. Blakiston's Son and Co., Philadelphia.

These outlines are intended to accompany a course of lectures on mammalian anatomy. They do not present a series of dissections of mammals but systems of organs are studied and any mammals best suited, or most convenient, are used for each study. The directions include microscopic study as well as the macroscopic. The studies appear to be carefully planned and thorough. W. W.

General Hygiene, by Frank Overton, A. M., M. D.; author of "Applied Physiology." Pages 382. 12 mo. With numerous text figures. American Book Company. *Personal Hygiene, by same author.* Pages 240. With numerous figures. American Book Company.

These two books are intended for young readers of grammar school age, but we should say that they are not too simple for the first-year high school pupil. The "General Hygiene" includes community hygiene and anatomy and physiology while "Personal Hygiene" is related to the individual. They appear to be good books, well written in a good, clear style, well arranged. They consider the subject from the modern standpoint and are not burdened with useless terminology and verbiage. The presentation of the topics is practical and very helpful with suggestions for personal application. W. W.

Foods and Sanitation, by Edith Hall Forster and Mildred Weigley of Northern Illinois State Normal School, De Kalb, Ill. Pp. 396. 1914. Price, $1.00. Row, Peterson & Co., Chicago and New York.

This book is the first adequate text on the subject of modern methods in food preparation and up-to-date sanitation, that has yet appeared. It is especially adapted to the use of high school and normal classes. It is unique in its treatment of food, in that the principle underlying the preparation of food is given first, and then its application. A student following carefully such a method should certainly be strong and independent.

It is excellent in its treatment of dietetics, giving up-to-date theories with references and authorities. One exception observed is the theory given in regard to decay of teeth, which differs from the accepted explanation of today.

The treatment of the planning, preparation, and serving of meals is particularly good.

One-fifth of the book is given to sanitation. The subject is not covered as completely as is the subject of food, but is very suggestively and helpfully treated. J. H. S.

The Source, Chemistry and Use of Food Products, by E. H. S. Bailey, University of Kansas. Pages xiv+517. 14.5x20.5 cm. Cloth. 1914. $1.60 net. P. Blakistons' Son & Co., Philadelphia.

One who has kept in touch with the new editions of scientific and mathematics texts which have come from the press during the last two years must have been impressed with the remarkable high worth of nearly all of them. This book is no exception to this high quality. It covers a field which heretofore has not been touched upon in this particular manner. The author has attempted to bring together into one volume the most important facts relating to the different kinds of food which we eat and drink. The book is, very largely a compilation of facts and statements, appearing in many books and pamphlets, which have thus been made accessible to the teacher and general reader. The book does not attempt to give one sufficient information as to how to raise and prepare for the table the various foods described. It does give descriptions, however, of the general methods of food production. The matter is arranged in as logical order as is possible in this particular line of work. Thus in the discussion of cane sugar and glucose confectionery is studied. It will be a splendid book to use as a text in this phase of educational work. A good conception of the book is obtained from the twenty chapter teachings which are here given: Sources and Constituents of Foods; Composition of Cereals and the Manufacture of Starch; Bread and Other Cereal Products; Sugar and other Saccharine Substances; Alcoholic Beverages; Roots, Tubers and Vegetables; Legumes; Cultivation, Preservation and Use of Fruits and Berries; Orchard and Vine Fruits; Berries, Garden and Miscellaneous Fruits; Mushrooms, Truffles, Algae and Lichens; Animal and Vegetable Fats and Oils; Nuts and Nut Products; Meat and Meat Products; Fish and Shell Fish; Milk and Dairy Products; Eggs and Egg Products; Spices and Other Condiments; Non-Intoxicating Beverages; Water and Effervescing Beverages. There is a very complete index of nineteen pages. It is clearly and plainly written. It is worthy of an extensive sale and doubtless will have such. C. H. S.

Technical Trigonometry, by Horace W. Marsh, Head of the Department of Mathematics, School of Science and Technology, Pratt Institute. Pages x+232. 14x21 cm. $1.50. 1914. John Wiley & Sons, Inc., New York.

As the name implies this trigonometry is of mechanic arts and for the man who is to design and build machinery, bridges, sewers, and so on. Very little attention is given to the general principles, relations, and properties of the angle functions; but by the insistence of careful drawing, orderly arrangements of proofs and solutions, and correct results there is no doubt but what students who have worked through this book will know how to solve the problems that may be required of them in their future manufacturing or technical pursuits.

In the style, arrangement of subject-matter, and beauty of diagrams this book together with the others already published in this series might well be taken as a standard of excellence by authors and publishers. As a reference book in non-technical schools it will help to vitalize this subject by emphasizing the practical side. H. E. C.

Second Course in Algebra, by William B. Fite, Professor of Mathematics in Columbia University. Pages v+243. 13×19 cm. 1914. D. C. Heath & Co., Boston.

This book shows the same qualities that distinguish the author's FIRST COURSE. Complicated and artificial problems have been avoided, and simple and natural applications in geometry and physics furnish problems that should interest the pupils. Two chapters have been added for use in schools that wish to meet the entrance requirements of certain colleges. As a simple and direct presentation of algebra with good collections of problems and exercises this book can be commended. H. E. C.

Memorabilia Mathematica, by Robert E. Moritz, Professor of Mathematics in the University of Washington. Pages vii+410. 17x23 cm. $3.00. 1914. The Macmillan Company, New York.

During ten years Professor Moritz has given largely of his time to this labor of love. He has made diligent search for exact statements, or the exact reference of more or less familiar passages relating to mathematics by poets, philosophers, historians, scientists, and mathematicians. This volume contains 2160 such quotations, and needs only to be seen to carry the conviction to any teacher of mathematics that it is a necessary part of his professional equipment as well as a source of personal enjoyment.

The quotations are arranged in chapters under the following headings: Definitions of Mathematics. The Nature of Mathematics. Estimates of Mathematics. The Value of Mathematics. The Teaching of Mathematics. Study and Research in Mathematics. Modern Mathematics. The Mathematician. Persons and Anecdotes. Mathematics as a Fine Art. Mathematics as a Language. Mathematics and Logic. Mathematics and Philosophy. Mathematics and Science. Arithmetic. Algebra. Geometry. The Calculus and Allied Topics. The Fundamental Concepts of Time and Space. Paradoxes and Curiosities.

A comprehensive index makes it possible to turn up any desired topic with little trouble. Printed on heavy paper with large clear type, and beautifully bound this volume is in all respects a *chef-d'oeuvre.* H. E. C.

Mathematics for Freshmen Students of Engineering, by Theodore Linquist, University of Chicago. Pages ix+135. 17x25 cm. 1911.

This dissertation submitted to the faculty of the Ogden Graduate School of Science, University of Chicago, in candidacy for the degree of Doctor of Philosophy, is a valuable report on the state and tendencies of engineering mathematics. In addition it includes a discussion of preparatory mathematics and other related subjects.

Data bearing on the mathematical instruction of freshmen engineers in 130 institutions in the United States offering one or more courses in engineering, is given in a table and these facts are collected in summary form for certain important phases of the work. The results of a survey of current thought on questions relating to engineering mathematics obtained by a questionnaire are given together with conclusions drawn from the replies. This report will be of service to those interested in the live topic of engineering mathematics. H. E. C.

A Geometrical Vector Algebra, by T. Proctor Hall, Ph. D., Vancouver, Canada. Pages 30. 16x32 cm. Paper. 1914.

The author gives the following description of his algebra: "In this algebra new definitions of vector multiplication and division are adopted, in consequence of which all algebraic operations upon vectors (directed unlocated straight lines or steps), or rather upon vector symbols, correspond to geometric operations in space upon the vectors themselves. This algebra is developed first in terms of analytic geometry for three-fold space, and it is then adapted to two-fold and to four-fold space. Complex numbers, spherical trigonometry, and quaternion rotations, appear as special cases." H. E. C.

Slide-rule Notes, by Col. H. C. Dunlop and C. S. Jackson, M. A. Pages 127. 13x19 cm. 75 cents. 1913. Longmans, Green & Company, London.

The slide-rule is coming into more general use in spite of the disposition of older teachers to disparage it. The student who gets a slide-rule early in his school work and uses it constantly will not only be able to make his computations with little loss of time, but also he will acquire habits of accuracy and of checking his results.

This book explains the theory and use of the slide-rule, and devotes considerable space to pointing out ways of securing results quickly and of avoiding errors. Methods of reading off the roots of quadratic and cubic equations are given. There are lists of practical problems for solution. H. E. C.

Elementary Household Chemistry, by Prof. Snell of MacDonald College. 307 pages. Macmillan and Company, New York.

Here is a text which should be of use to the teacher of home economics in two ways; first, as a reference for her own and class use, second, as a guide in organizing general or applied courses in chemistry or general science, to be given as part of the home economics curriculum.

The author states that his own use of the course here presented has been with a class of (college) students mostly with no previous chemistry training. "The principle which has been kept constantly in mind is to introduce the applications of chemistry to household affairs as early and as often as possible, and to present only such portions of the subject matter of theoretical chemistry as is essential to the comprehension of these applications."

Organic chemistry begins with page 132, and includes experimental studies and descriptive text taking up the chemistry of foods (40 pp.), digestion (6 pp.), dietetics, textile fibres and treatment (49 pp.), soaps and cleaning (18 pp. besides about 9 pp. previously given on tarnishes and rust).

The style is lucid and illuminating, the material is skillfully presented from the pedagogical standpoint (so far as the reviewer, who lays no claim to expert chemical knowledge, is able to judge). M. C. D.